NATURE

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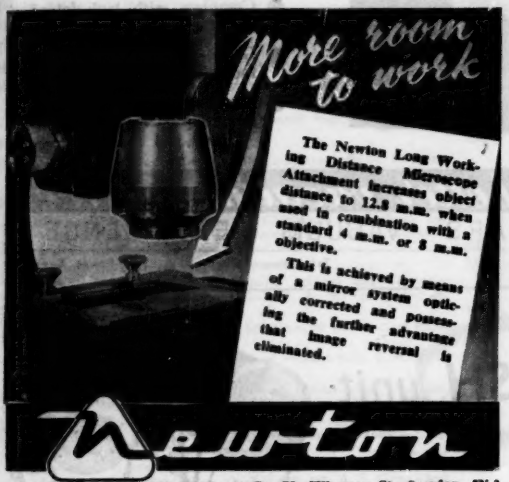
Of nature trusts the Mind that builds for aye."—Wordsworth

VOL. 168, NO. 4266 SATURDAY, AUGUST 4, 1951 TWO SHILLINGS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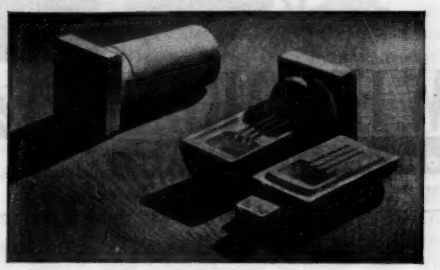

Full details of the application of differential thermal analysis technique for the determination of the constitution of refractory clays is given in the Trans. of British Ceramic Soc., 1945, Vol. 44, page 69.

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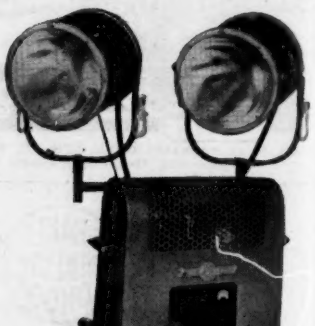

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INTERNATIONAL NATURE CONSERVATION

THE English version of the Proceedings and Reports of the second session of the General Assembly of the International Union for the Protection of Nature, which was held in the Solvay Institute of Sociology at Brussels during October 18–23, 1950, has now appeared. The other, the French, version was published somewhat earlier. It is therefore a convenient moment to take stock of the position, to review the course of events which led to the establishment of an international body with the object of preventing the threatened extermination of species or associations of plants and animals, and to survey what has been accomplished and what is contemplated in the future.

The concept that Nature needs protection from the multifarious activities of man was first recognized in comparatively recent times, for it was only in the industrial age, when he had harnessed to his use mechanical power, that the destruction of the wild life of extensive areas was seriously threatened. The first incident to attract the attention of the civilized world was the disappearance in the seventeenth century of the helpless and harmless dodo, not of intent, but through sheer thoughtlessness and negligence. A greater disaster was narrowly averted in the nineteenth century, when with the rapid extension of the cultivation of the prairies of north-west America the bison diminished in numbers with corresponding rapidity. Thanks, however, to the timely action taken by the Governments of the United States and Canada, the animals that still survived were gathered together into safe-keeping in reserves, and the species was saved. Another phenomenon which attracted even wider attention, because commercial interests were involved, was the marked diminution in numbers, almost to the point of extinction, of whales in the Arctic seas. Late in the nineteenth and early in the present century, many nations spontaneously formed societies and took legislative action, in order to safeguard the wild life in their respective countries. It was, however, soon realized that individual action was not enough, and that international co-operation was needed, because in so many instances animals, especially birds, disregarded national frontiers, and it was of little use one country protecting a species if its neighbours destroyed it; moreover, life in the open seas necessarily demanded mutual understanding among the maritime nations.

In the early years of the present century, spasmodic efforts were made to initiate some form of international agreement for the protection of Nature; but beyond the passage of pious but fruitless resolutions they led to no positive results. The celebrated Swiss naturalist, the late Dr. Paul Sarasin, whose name is perpetuated by a tablet on a slab in the Swiss National Park, may justly be said to have laid the foundations upon which others built. At the eighth International Congress of Zoology, held at Graz in 1910, his proposal for an international commission was adopted, and, what is more, a provisional

committee was appointed to follow the matter up. As a consequence, in 1913, under the auspices of the Swiss Federal Government, an international conference was held at Berne, and resulted in the adoption of an Act of Foundation of an Advisory Commission for the International Protection of Nature with its seat at Basle. With the ratification of the Act by a sufficient number of nations it looked as if success had been achieved. Unhappily, the First World War supervened, and the movement was not only temporarily brought to a standstill, but was also found impossible of resuscitation on the restoration of peace. Dr. Sarasin did make a determined effort to revive the movement at the International Congress for the Protection of Nature at Paris in 1923, but without definite result; and he died in 1929. His work was, however, carried on by Dr. P. G. van Tienhoven, who had taken a prominent part in securing the protection of Nature in the Netherlands. He was successful in forming the International Office for the Protection of Nature; but, in spite of his valiant efforts, the general response throughout the world was lukewarm, and, although the Office carried on, and indeed still functions, the lack of sufficient financial support has limited its activities to the accumulation of documents relating to the subject.

It may be noted in passing that, although the Second International Congress for the Protection of Nature, held at Paris in 1931, failed to achieve general international co-operation, it led directly to the Conference of the African Powers in London in 1933, which resulted in the Convention for the Protection of the African Fauna and Flora. A very similar convention for Nature protection and wild-life preservation in the western hemisphere was drafted at the Eighth Pan-American Scientific Congress, held at Washington in 1940, and became effective in 1942.

At the close of the Second World War, the Swiss League for the Protection of Nature, mindful of Dr. Sarasin's achievements, bestirred itself, and as a start invited naturalists from various European countries to visit the Swiss National Park and Reserves in the summer of 1946; and at the end of their visit they were induced to discuss informally the international aspect. Stimulated by this experience, the League embarked upon a more ambitious project, and issued invitations to governments, government institutions, and voluntary societies to participate in an international conference at Brunnen in the summer of 1947. The object in view appeared to be the revival of the Act of Foundation of 1913; but the general feeling among the delegates was that it would be a mistake not to take note of the change in political conditions, and especially the creation of the United Nations Organization, and that what was needed was not an Advisory Commission but an international union which could be linked up with the United Nations Educational, Scientific and Cultural Organization (Unesco). An appropriate constitution was accordingly drafted, and, after approval by the Conference, was transmitted to Unesco with the request that it should convene an international conference for the purpose of founding a union. After some hesitation owing to the fact that doubt was felt whether the proposed union might be considered to come within its objects, Unesco agreed, and under the joint auspices of it and the French Government an international conference, attended by delegates from thirty-two countries, took place at Fontainebleau at the beginning of October 1948.

As a result of this conference, the International Union for the Protection of Nature was formed with its seat at Brussels, Dr. Ch. J. Bernard being elected president and Mr. Jean-Paul Harroy secretary-general. Its constitution was largely based upon the one adopted at Brunnen. Its membership is unusual in character, being a combination of official and private bodies; it is of four classes: (*a*) governments; (*b*) public services concerned with the protection of Nature; (*c*) international (inter-governmental and non-governmental) organizations, institutions and associations concerned with the protection of Nature; (*d*) non-governmental national organizations, institutions and associations concerned with the protection of Nature. In order to assure the over-riding power of governments, in the General Assembly the government of each country has two votes, but all its national bodies together only one vote. In view of this voting arrangement, the British Co-ordinating Committee for Nature Conservation was formed as a committee of the Society for the Promotion of Nature Reserves, in order to formulate a common policy for the non-governmental bodies of Great Britain; the appropriate government departments are, however, represented at meetings of the Committee by observers, as also are certain other British countries. By Treasury regulation, subscriptions to the Union from private bodies have to be transmitted through the Committee, the maximum amount in any one year being restricted.

The first major piece of work to be undertaken by the newly formed Union was, at the request of Unesco, the organization of an International Technical Conference at Lake Success in August 1949 concurrently with the United Nations Scientific Conference for the Conservation and Utilization of Resources. The subjects discussed were grouped under two main headings, education and ecology, and a large number of resolutions were adopted for submission to the General Assembly of the Union. The second session of the General Assembly was held at Brussels towards the end of October 1950, and was attended by 103 delegates representing thirty-one countries, together with eighteen observers from eleven international organizations; the actual number of persons present was not so large, because in many instances the same individual represented more than one body. After consideration of the report of the Union's activities since its formation two years before, the main business was the consideration of the resolutions submitted by the Lake Success Conference, the Unesco representative relating what that body had already done to implement them. Since the success of the Union must ultimately depend upon the public support it is able to attract, an important step towards this end was taken by setting up an

Educational Section, with wide discretionary powers, at Washington under the chairmanship of Mr. Ira N. Gabrielson. A Survival Service was formed with the object of stimulating measures for the preservation of the species in grave danger of extinction which had been listed at Lake Success. Another important piece of work, which was rendered possible by financial assistance from Unesco, was the collecting and collating of information about the state of Nature conservation in different countries throughout the world; the volume has now appeared. The urgent need for an official periodical to provide information about the Union and its activities was recognized, but the stumbling block which was found impossible to circumvent was the absence of funds adequate to meet the inevitable cost, at least initially.

In fact, the obstacle blocking the Union's progress is the want of adequate financial resources. It is in the grip of the familiar vicious circle: on one hand it is starved of funds, and on the other criticized for apparently doing so little. Under the constitution, government and non-government bodies are expected to subscribe annually 50 American dollars, whereas the subscriptions for governments depend upon the population of their respective countries, ranging from 250 dollars for those with less than 5 million inhabitants to 2,000 dollars for those with more than 20 million inhabitants. It therefore follows that the contribution by the government of a large country is equal to the combined total of forty organizations. Moreover, in the existing difficult circumstances, comparatively few societies can easily afford the unit subscription, in view of the fact that with the rise in costs they can barely meet their commitments. It would obviously make all the difference if governments generally were to adhere to the Union; but unhappily as yet only those of four countries—Belgium, Luxembourg, the Netherlands and Switzerland—have done so. In the United Kingdom the Government has not itself adhered; but the British Museum (Natural History) and the Nature Conservancy have become members. For the sake of the future of the Union, it is sincerely to be hoped that it may be supported by a larger number of governments. In certain instances there may be some hesitation for fear lest the government might be committed to a course of which it did not approve; but this objection has been met by the provision that no government is bound by a decision of the Union, even if at the time it was approved by its own delegates.

A FEAST OF FAREY FRACTIONS

The Farey Series of Order 1025

Displaying Solutions of the Diophantine Equation $bx - ay = 1$. Designed and compiled by E. H. Neville. (Royal Society Mathematical Tables, Vol. 1.) Pp. xxix+405. (Cambridge: At the University Press, 1950.) 105*s*. net.

THE Farey series F_n of order n is the ascending series of irreducible fractions between 0 and 1 the denominators of which do not exceed n. For example, F_5 is 0/1, 1/5, 1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 1/1, and so contains eleven terms. The series compiled by Prof. E. H. Neville is F_{1025}; it contains 319,765 fractions and occupies four hundred pages. In addition, tables of F_{50} (with decimal equivalents), F_{60} and of the denominators in F_{100} are given as appendixes. A loose card containing the factors of all the numbers between 1 and 1049 is issued with the volume. The preparation of a table of this magnitude is a considerable feat, and Prof. Neville must be congratulated on having completed such a formidable task.

Farey series have a variety of interesting properties and uses. If a/b, a'/b' and a''/b'' are consecutive fractions of such a series, then (1) a'/b' is the mediant of a/b and a''/b'', that is, $a'/b' = (a + a'')/(b + b'')$, and (2) $ba' - ab' = 1$. Properties of this kind can be used when it is desired to approximate to a given irrational number α by means of a rational number a/b. It is first necessary to find the consecutive fractions a/b, a'/b' of F_{1025} between which α lies; convenient ways of doing this are described. If it is desired to approximate to α more closely than this, the problem becomes essentially that of finding the fractions of a Farey series of higher order which lie between a/b and a'/b'. Prof. Neville shows how this can be done in an economical way by making further use of his main table.

Another use of Farey series is to provide solutions x and y of the Diophantine equation $bx - ay = 1$ for given a and b without a common factor. If b does not exceed 1,025, the property (2) suggests a solution, since the equation is satisfied by $x = a'$, $y = b'$ where a'/b' is the successor of a/b in F_{1025}; other neighbouring terms also give solutions in certain cases. If b exceeds 1,025, the fraction a/b belongs to a Farey series of higher order, and the methods mentioned in the preceding paragraph can be used to provide solutions. In fact, by using the main table, or that of F_{50} with its decimal equivalents, the equation can be reduced by stages to one which is easily solved.

When one is confronted with a work of the magnitude of Prof. Neville's, one cannot help reflecting upon the grounds which justify the publication of tables in the theory of numbers. A list of gear-ratios arranged in order of magnitude is a Farey series, but even the engineers of the distant future are likely to find the scope of the present table beyond their requirements. Thus, so far as can be foreseen, other grounds of justification than those of practical use must be sought. It is possible that some would claim that the compilation of such a table is a contribution to human knowledge and so requires no further justification. Most of us would feel, however, that some discrimination must be exercised, and that the main justification of this kind of work lies in the use made of it. There are at least three different ways in which number-theoretical tables can be used. First, such a table may assist and shorten calculations made for purposes which are conceded to be of importance; a table of prime numbers is an obvious example. Secondly, a table may help to decide the truth or falsity of some important conjecture; Ramanujan's conjecture concerning the magnitude of his function $\tau(n)$ is a case in point. Thirdly, the study of a table may reveal the existence of hitherto unknown properties of the numbers tabulated; thus it was after studying Henry Goodwyn's table of Farey fractions that John Farey observed the mediant property (1), and in more recent times

multiplicative properties of arithmetical functions have been discovered in a similar way.

As has been indicated, Prof. Neville's table can be used to solve particular problems of Diophantine analysis. Even a number-theoretician could not pretend, however, that such problems are of common occurrence, although the associated general problems are among the most interesting and difficult in number theory. It may be, of course, that future researches will make extensive use of the table for these or similar purposes. However, in my opinion it is largely for its possible uses to future Ramanujans in suggesting general properties hitherto unnoticed that Prof. Neville's table is justified. Whether such hidden properties do, in fact, exist it is not possible to say, although the recent elegant extension by Mahler, Ledermann and Cassels of Farey series to fractions in certain algebraic fields suggests that the subject is by no means exhausted and that there may still be scope for Farey's "curious calculators".

The book is beautifully printed in the usual competent style of the Cambridge University Press and is very appropriately dedicated to Srinivasa Ramanujan.

R. A. Rankin

THEISM AND THE INDIVIDUAL

The Christian Challenge to Philosophy

By the late W. H. V. Reade. Pp. xiii+195. (London: S.P.C.K., 1951.) 13*s*. 6*d*. net.

THIS book is the work of a Fellow of Keble College, Oxford, who died in 1943, leaving his manuscript prepared for publication. The author's character is sketched for us, simply and sympathetically, in a preface by Mr. Cyril Bailey, to whom the reader will be under a considerable debt. We are confronted by the picture of a master mind, embedded in a personality at once saintly, witty, artistic and shy. Mr. Reade cannot have been easy to know; but he made a lasting impression both as a teacher and as an official. Add to these conditions, the evening of a longish life, plus retirement from active academic affairs amid the darkest period of the Second World War, and we have the setting for the composition of these remarkable essays.

Perhaps their most outstanding feature is an utter lack of self-consciousness in following a theme to the bitter end, a theme not merely committed to paper, but lived and tested. To read these pages without realizing all this would be a sad mistake.

So, a beginning is made with the year A.D. 529, when the Emperor Justinian closed the Academy, and Greek philosophy was thereby officially declared to be dead. Oddly enough, we are not escorted forwards chronologically from here, but backwards towards its birth. This process brings to light—among other things—the almost incredible heterogeneity of the Pythagorean society, in which learned men found themselves apparently in close association with incorrigible purveyors of old wives' fables. Yet, in some respects how modern. Music was studied as a theoretical discipline, having little or no regard for composition or technique, and the fact that strong emotions were engendered by "sheer sound" only serves to remind us how primitive the basis must have been.

Nevertheless, philosophy was a way of life; it was, indeed, something to be used, something to be experienced. Above all, it had not yet become a 'subject' for study in the sense assigned to it by a university faculty. Its leaders, however, made a decisive step, commonly unknown, but if recognized, then seriously belittled. They invented theology as a protest against religion; not against established religion, but against all sorts of debased superstitions and myths. Yet theologians themselves must have increased in mental stature at a very uneven rate. Originally they appear as tale-tellers about the gods, nothing more, whereas Aristotle, having early contrasted them with 'physicists', later raises their status to that of a class interchangeable with "first-philosophers" or metaphysicians. Evidently, no longer had they anything to do with myths, and something quite fresh had been added to the Pythagorean outlook. All of which goes to show the complexity of the *logos* concept on its way to become a Christian tenet, central for doctrine and devotion alike.

From here it is a natural step to the fundamental position which this volume takes up regarding the absolute rejection of Platonism by Christianity. There is no half-way house, only complete incompatibility. Plato never seriously considered whether the altars (as he conceived them) about which, some centuries later, the Apostle to the Gentiles made his well-known comment, were dedicated to the one eternal Spirit, or whether their aim was essentially mythical. Thus there is for him (Plato) no theophany in history, no revelation of God "beyond the scope of science" to be uncovered by faith. Closely coupled with these elemental distinctions is Mr. Reade's major demand that religion was never for the few—in particular, the intellectually gifted—but for all from the least to the greatest. Here, certainly, the Christian challenge to philosophy is made manifest.

The reader is invited to study the later chapters of this book more especially if he is interested in modern problems thrown up by twentieth-century civilizations. He would be well advised, however, to receive this considerate suggestion with caution, since an understanding of the medieval scene, brilliantly delineated in the middle sections, is absolutely necessary if any significant judgment is to be reached regarding our present discontents. Incidentally, there is a valuable discussion concerning the relative positions of theology and philosophy in the hierarchy of learning. Mr. Reade avoids the decisive grading of the Western tradition: if philosophy is not exactly a "serving-maid", theology is no more than a first among equals, or perhaps between equals. This is no mere playing with words; it represents very fairly the Anglican position at its best, and markedly so when account is taken of the isolation of scholarship some eight years ago.

Along paths like these, the author approaches the climax of his argument. It amounts to a stern warning against all forms of riding roughshod over the individual, whether that word denotes persons or things. Every person is unique, and to be held in reverence on that account; moreover, many 'things' are unique—objects of great art, for example—and incapable of statistical evaluation. This axiological outlook is of the very core and substance of all Christian striving, and is bound to do battle against any philosophical system involving mass-production, mass-thinking, mass-behaviour, and the rest. It is inappropriate to enlarge upon the purely ecclesiastical functions implicit in such a way of life—suffice it to add that they receive their share of Mr. Reade's erudition and good sense. But there is one phrase

(on p. 27) which seems like a slip, namely, "the opinionated man, tenacious and dogmatic . . .". Surely this is, in part, a tautology if the Greek δόξα is accorded its usual rendering.

The proof-reading must have been exemplary, and the format is attractive. This is a book to be bought rather than borrowed. It will not find easy acceptance, nor make rapid converts. But if neglected, it may well be at our peril. F. I. G. RAWLINS

PURE AND APPLIED CHEMISTRY OF STARCH

Chemistry and Industry of Starch

Edited by Dr. Ralph W. Kerr. Second edition, revised and enlarged. Pp. xii+719. (New York: Academic Press, Inc., 1950.) 11.50 dollars.

BEFORE the first edition of this book was published in 1944, more than four thousand papers had appeared on the subject of starch, and the late H. E. Armstrong once used the expression "the tragedy of starch" in reference to the subject. Since 1939 matters have changed, and so far as chemical structure is concerned a much clearer picture is now possible, although one would welcome further advances in the physical properties and the industrial applications of starch and its products.

This excellent book—now in its second edition and greatly enlarged—is described as "Edited by Ralph W. Kerr", and it is true that his co-authors have contributed a number of chapters, but it is largely the author's own work. In many parts, particularly those in which he is dealing with scientific aspects of the subject and in which his own investigations have contributed to what is known, the author writes critically, with a command of his subject and adequate familiarity with the work of others.

The book is in five sections, of which the first deals with the starch granule and the chief varieties of starch. Section 2, comprising five chapters, is concerned with the manufacture of various types of native and modified starches, the chapter on corn starch having been rewritten for this edition. Section 3 comprises two chapters on the physical properties (by Dexter French) and the chemical properties of starch, both critically written and including developments, almost up to the time of writing, in the synthesis of starch components.

Section 4 deals with reactions and includes chapters respectively on the hydrogen bond as a basis for interpreting certain starch properties and on dextrinization, both by G. V. Caesar, oxidation (by J. M. Newton and G. T. Peckham), the manufacture of dextrins and acid hydrolysis of starch, and a long one (by Ed. F. Degering) on derivatives, with more than three hundred references. Most of these chapters have been enlarged in the present edition and give clear evidence of the authors' practical experience of the matters under discussion. The amylases are excellently reviewed by E. Kneen, and modification of starch by enzymes treated by G. M. Severson. A chapter on miscellaneous reactions has been greatly enlarged in this edition to include new work on the interaction with iodine.

Section 5 comprises one chapter on the analysis of starch (this is a new chapter) and six on its uses in industry—for example, modern fermentation products (by L. M. Christensen), food, paper, textiles, adhesives (by A. Frieden) and miscellaneous uses. The chapter on starch in fermentation industries has been enlarged, while the practical, technical and commercial aspects are well treated in the various chapters on the uses and applications of starch.

There are pages of references to each chapter of the book, and complete author and subject indexes and numerous illustrations, both photographic and diagrammatic. The photographic illustrations are better finished than in the first edition. An error in many of the page headings in the chapters on the physical and chemical properties of starch reverses these titles. The book will be invaluable to the pure scientist and the technologist. R. H. HOPKINS

THE ELECTRON MICROSCOPE IN METALLURGY

Metallurgical Applications of the Electron Microscope

A Symposium held at the Royal Institution, London, on 16 November 1949, and organized by the Institute of Metals in association with the Chemical Society, the Faraday Society, the Institute of Physics, the Institution of Electrical Engineers, the Iron and Steel Institute, the Physical Society, and the Royal Microscopical Society. (Institute of Metals Monograph and Report Series, No. 8.) Pp. vi+164+50 plates. (London: Institute of Metals, 1950.) 21*s*.

MAGNIFICATIONS beyond the range of the ordinary microscope are of metallurgical importance in many directions. Examples are to be found in the nature of the irresolvable constituents of hardened and tempered steels, the mechanism of age-hardening, the nature of the crystal boundaries and precipitations of ultra-microscopic films there. Further, the fundamental nature of plastic deformation, the real nature of slip bands, and the size of the fragments into which metallic crystals are broken down, all demand a technique beyond the range of normal microscopic vision.

Therefore, the symposium on the "Metallurgical Applications of the Electron Microscope", organized by the Institute of Metals in November 1949, in conjunction with a number of other societies interested in the same or similar problems, served to bring together a considerable mass of information regarding the potentialities of this instrument in the metallurgical field. The symposium was perhaps the more justified in that there has been, at any rate in some quarters, a feeling of disappointment at the progress so far made. The thirteen papers are now published by the Institute of Metals as Monograph No. 8, and cover the whole field, ferrous and non-ferrous, metal powders, heat treatment and mechanical working.

The widespread interest in the subject is exemplified by the fact that universities, research associations and industrial laboratories in Great Britain, United States, France and Germany have all contributed. To all those concerned, either from the fundamental or technological point of view, this collection of data is to be strongly recommended. Techniques for the production of replicas are discussed; and, although what the metallurgist would most like, namely, a direct picture of the metal surface, is unfortunately not yet available, the design and construction of a reflexion electron microscope may not be long delayed. F. C. T.

BRITAIN'S SCIENTIFIC SHRINES (5)

By Eng.-Capt. EDGAR C. SMITH, O.B.E., R.N.

SCOTLAND

FOR carrying the survey of Britain's scientific shrines into Scotland, the plan adopted for the English counties is scarcely applicable, for some of Scotland's largest counties are the most sparsely populated, while for the greater part the homes and haunts and memorials, if not the birthplaces, of notable Scottish men of science are to be found in her university towns. The story of science in Scotland centres around her universities far more than is the case in England, and Scotland presents few parallels to the careers of such as Gilbert, Hales, Priestley, Jenner, Cavendish, Herschel, Dalton, Joule and Darwin. Some of England's most eminent men of science, owing to the religious tests, never entered Oxford or Cambridge, and were debarred from holding professorships in them. But in Scotland, with her educational traditions handed down from the days of John Knox, any student who could fend for himself on a meagre ration found the doors of the universities open, and, after the Reformation, the religious question seems to have shut them against very few. In attempting in a brief, and admittedly inadequate, sketch to recall to the reader some of those whose names are inscribed on the rolls of honour in science in Scotland, some part of the story of the universities must inevitably form the background.

Of the four Scottish universities, those of St. Andrews, Glasgow and Aberdeen came into existence before the Reformation, and that of Edinburgh just after; and their fortunes were affected not only by the struggles between Catholics and Protestants but also by the constant disputes between rulers, nobles, chieftains and clans, all of which were accompanied by much disorder. Recalling the circumstances, the impoverished state of the country, and the smallness of the population, it is not a little surprising that the universities managed to exist at all. In one of his many studies of the social history of Scotland, the Rev. H. G. Graham (1842–1906) said that even by 1650, after the Crowns of England and Scotland had been united, the total population of the country was only about 900,000, while the inhabitants of Glasgow numbered about 10,000, those of Aberdeen some 6,000, and those of St. Andrews a mere 1,500. One of Mr. Graham's essays was entitled "Glasgow University Life in Olden Times", in which he gave a striking picture of the hard and penurious life of both teachers and taught. Here, as elsewhere, the religious upheaval had its baneful effects on the young university, and with the coming of the Reformation, wrote Mr. Graham, "away fled Popish churchmen, students and masters, and when we see the august University once more all that is left of it consists of twelve individuals: a principal, three regents, four poor students, the principal's servant, an œconomus, a cook and a janitor. To such a miserable remnant are the functions and privileges left, with a meagre revenue of £25 yearly." From this deplorable state of things the University was rescued by the reformer and universal scholar, Andrew Melville (1545–1622 ?), who in 1574 at the age of twenty-nine, constituting the whole teaching staff in himself, lectured on Greek, Hebrew, Chaldee, Syriac, philosophy, physics, logic, rhetoric and chirology, and soon filled his rooms with students. In 1580 Melville returned to St. Andrews; but he had put the University of Glasgow on its feet again and by 1631 the half-ruined houses and tenements sheltering both professors and students were being replaced by the College in the High Street, which was destined to see the labours of a long line of distinguished men, including Adam Smith, Cullen, Black and their great successors, Thomas Graham, Rankine and Lord Kelvin. The ancient cathedral, in a part of which the University first met, still stands majestically at the top of the High Street, and at the foot of the hill the visitor can stroll through Glasgow Green, where on one Sunday afternoon in 1765 James Watt, pondering over the working of the University's model Newcomen engine, conceived the idea of a separate condenser. But all traces of the College which served the University for more than two centuries have been swept away, though some fragments of its masonry are incorporated in the Gatehouse at Gilmorehill.

With such a curriculum as that of Melville there was little room for mathematics; but it is worth noting that Melville's career coincided almost exactly with that of John Napier (1550–1617), who in the seclusion of Merchiston Castle, near Edinburgh, spent the greater part of his life in study and gave to the world his famous work on logarithms. He, like Melville, had studied at St. Andrews, and spent some time on the Continent, before marrying and settling down in his ancestral home. Ball says of him that "the business of his life was to show that the pope was anti-Christ but his favourite amusement the study of mathematics and science". It may be presumed that to-day no one reads Napier's commentary on the Apocalypse, but logarithms are in use all the world over. His famous book, "Mirifici Logarithmorum Canonis Descriptio", was published in 1614, and its tercentenary was the occasion of a notable commemoration by the Royal Society of Edinburgh, presided over by Lord Moulton, "a distinguished mathematician before he was a great lawyer". In his inaugural address, Lord Moulton said that though every fact known about Napier had become commonplace, it "left the man very imperfectly disclosed, but sufficed to show him strong and self-reliant, of solitary habits, of profound and untiring industry . . .", while "the invention of logarithms came on the world as a bolt from the blue. No previous work had led up to it, nothing had foreshadowed it or heralded its arrival. It stood isolated, breaking in upon human thought abruptly without borrowing from other workers or following known lines of thought." There were many other contributions to the tercentenary commemoration, which were all published in a special volume edited by Dr. C. G. Knott, a member of the staff of the University of Edinburgh, which was founded when Napier was engrossed in his studies at Merchiston Castle. Napier died on April 4, 1617, and was buried in the old church of St. Cuthbert. Among the memorials to him is his statue, which stands beside those of John Hunter, James Hutton, Sir Henry Raeburn and others in the Scottish National Portrait Gallery.

The next important figure in the history of science in Scotland is that of James Gregory (1638–75), who

was educated in the University of Aberdeen and held the chair of mathematics first at St. Andrews and then at Edinburgh. The University of St. Andrews was founded in 1411 by Bishop Henry Wardlaw, that of Glasgow was founded in 1451 by Bishop Turnbull on a bull issued by Pope Nicolas V, a great patron of art and literature, while that of Aberdeen was founded in 1494 by Bishop William Elphinstone on a bull issued by Pope Alexander VI, who has been described as the most profligate prelate who ever sat on the apostolic throne. Whatever Alexander's misdeeds, Aberdeen benefited by his sanction for the establishment of its University, and it was not long before the present King's College was built, to be followed about a century later by Marischal College, founded in 1593 by George Keith, the Earl Marischal of Scotland. The present Marischal College dates only from 1906, when it was opened by King Edward VII.

Among those who were educated at King's College was Dr. Duncan Liddel (1561–1613), to whom Aberdeen owed its first chair of mathematics. A native of Aberdeen, Liddel spent the years 1579–1607 at various places in Germany, studying and teaching philosophy, medicine and mathematics, and making the acquaintance of Tycho Brahe. Returning home in 1607 with a comfortable fortune, he gave land to the University of Aberdeen and before his death made provision for founding a chair of mathematics at Marischal College. His death took place on December 17, 1613, and a memorial to him was placed in St. Nicolas Church. It was about forty years after Liddel's death that James Gregory became a student at Marischal College, and it was at Aberdeen he published his treatise on optics and invented the Gregorian form of reflecting telescope. He further increased his reputation by his visits to London and to Padua, and on June 11, 1663, was elected a Fellow of the Royal Society. Soon after this he was made professor of mathematics at St. Andrews, and in 1674 he was elected the first exclusively mathematical professor in the University of Edinburgh. His inaugural address was delivered in November 1674. Eleven months later, while showing his students the satellites of Jupiter, he was struck blind and died three days later at the age of thirty-six. He had, however, already done enough to give him a place among the immortals, and in 1938 both St. Andrews and Edinburgh joined in commemorating the tercentenary of his birth.

But James Gregory was only one of a remarkable family of men of science, members of which for two hundred years held professorships in one or other of the Scottish universities. They were the Bernoullis of Scotland. The founder of the family was David Gregory, minister of Drumoak, near Aberdeen, and from his two sons David (1627–1720) and James (1638–75) the dynasty descended. Science seems to have been in their blood, and one of them belonging to the sixth generation, Duncan Farquharson Gregory (1813–44), a Cambridge wrangler and the first editor of the *Cambridge Mathematical Journal*, appears to have been cast in the very same mould as his famous ancestor James. Omitting much that is of interest, a word or two should be said about the third David Gregory (1661–1708), one in a family of thirty-two children, because in 1683 he was elected to the chair previously held by his uncle; secondly, because he was the first in Edinburgh to teach the Newtonian philosophy; and thirdly, because he was the first Scottish mathematician to occupy a chair in an English university, being appointed in 1691 Savilian professor of astronomy at Oxford. That his influence was felt far outside Edinburgh is shown by Whiston, who in his memoirs said that in his own study of the "Principia" he was "greatly excited thereto by a paper of Dr. Gregory's when he was professor in Scotland wherein he had given the most prodigious commendations to that work, as not only right in all things, but in a manner the effect of a plainly divine genius, and had already caused several of his scholars to keep acts, as we call them, upon several branches of the Newtonian philosophy; while we at Cambridge, poor wretches, were ignominiously studying the fictitious hypotheses of the Cartesian, which Sir Isaac Newton had also himself done formerly . . .". Among Gregory's students who had "kept the acts" was John Keill (1671–1721), who accompanied his instructor to Oxford, opened at Hart Hall the first course of lectures in the new philosophy given in the University, and afterwards was given the Savilian chair of astronomy. In a previous article, mention has been made of David Gregory's monument at Maidenhead. His successor's tomb is in St. Mary's Church, Oxford.

The progress of scientific studies in Scotland in the seventeenth and eighteenth centuries and the outlook of her men of science were affected by many causes. With the union of the Crowns of England and Scotland in 1603 and the union of their Parliaments a century later, together with the diminution and disappearance of internal strife in both countries, came a loosening of the bonds between Scotland and France, and an increase in the intercourse between north and south of Britain with advantage to both. With London as the capital of the united kingdoms, it was only natural for the more adventurous to seek their fortunes in it, and from the early eighteenth century onwards Scottish men of science are found in ever increasing numbers taking their place in the scientific institutions of the capital. The very first president of the Royal Society was the Scotsman Sir Robert Moray, and among his successors in the eighteenth century were the Earl of Morton and Sir John Pringle. Pringle, like Moray, Watt, Telford, John Hunter, Baillie, Simpson, Lyell, Kelvin and Ramsay, is among the Scottish men of science buried or commemorated in Westminster Abbey.

It is generally admitted that in the eighteenth century the study of mathematics made little progress in England. It was much the same in Scotland, although in Colin Maclaurin (1698–1746) Scotland had one of the first mathematicians of the day, and his death in the Archbishop of York's Palace through illness brought on by his exertions in organizing the defences of Edinburgh against the Jacobites in 1745 was a very great loss. Maclaurin was much interested in astronomy, and had encouraged his pupil James Short (1710–68), the famous London telescope maker; but on the whole astronomy attracted few Scottish students. There was, however, much greater activity in the realms of chemistry and physics, which, like botany, were regarded as the handmaids of medicine, and were studied as such and not as separate sciences to be pursued for their own worth. Almost without exception, teachers in the Scottish universities possessed a medical degree, and it was as a great centre of medical education that Edinburgh became famous. On this matter there are many interesting notes in a paper by Mr. J. N. J. Hartley, entitled "The Early History of the Museum of the Royal College of Surgeons of Edinburgh", and published in the *Edinburgh Medical Journal* of 1948.

Mr. Hartley is the conservator of the museum housed in Surgeons' Hall, and in the course of his remarks he gives particulars of some of the many teachers and schools of medicine and anatomy, referring especially to the first Alexander Monro (1697–1767) or Alexander Monro "*Primus*", who was appointed in 1720 by the Town Council to be the first professor of anatomy in the University. Of this distinguished man, Sir Alexander Grant wrote: "he was not only the Father of the Edinburgh Medical School, but also the first professor of any kind who drew great attention to the University of Edinburgh from without and gave it the beginnings of its celebrity".

It was while Monro was thus adding to the reputation of Edinburgh that the University of Glasgow became almost as famous, partly through the work of William Cullen (1710–90) and Joseph Black (1728–99). A biography of Black was the last book written by Sir William Ramsay. In it is an illustration of the old College in the High Street, in which, Black lived and worked, and reproductions of Kay's portraits of Cullen, Black, Adam Smith and James Hutton. Cullen was the first to teach chemistry at Glasgow as a separate subject, he was the first to lecture in the vernacular instead of Latin, and in 1755 at Glasgow he published his fruitful essay on "Cold produced by Evaporating Fluids". From 1746 onward the careers of Cullen and Black were linked together, for Black was Cullen's pupil and his successor in the chair of chemistry at Glasgow in 1756, and again in the chair of chemistry at Edinburgh ten years later.

Though Black lived to the age of seventy-one and came to be regarded as the Nestor of British chemists, his two great discoveries of the nature of 'fixed air' and the doctrine of latent heat were made while he was a young professor at Glasgow. Among other men of science associated with Glasgow in the eighteenth century were Dr. Robert Simson (1687–1768), professor of mathematics for nearly fifty years, whose "Elements of Euclid" formed the basis of numerous editions; John Anderson (1726–96), the somewhat litigious professor of natural philosophy, who sent a gun to Paris as evidence of his sympathy with the French Revolutionaries, and who by his will founded the famous Andersonian Institution, now incorporated in the Royal Technical College, Glasgow; Alexander Wilson (1714–86), who while engaged in typefounding became Glasgow's first professor of astronomy; Thomas Melvill (1726–53), the young divinity student who with Wilson recorded the temperature of the upper air by means of kites, and was the first to use a prism for examining the effect of introducing salts into the flame of burning spirits; John Robison (1739–1805), the close friend of Watt, who during 1774–1805 was professor of natural philosophy at Edinburgh; and William Irvine (1743–87), who held the chair of chemistry at Glasgow during 1770–87. In the story of Scotland's heritage of science, all these Glasgow worthies hold an honourable place.

Black's removal to Edinburgh occurred at a time when, in the words of Sir Archibald Geikie, "the Scottish capital had not yet begun seriously to suffer from the centripetal attractions of London. It was the social centre of Scotland, and retained within its walls most of the culture and intellect of that ancient kingdom." At Edinburgh, Black not only found his old master Cullen but also the philosopher Adam Ferguson (1723–1816), then professor of "pneumatics and moral philosophy", and Matthew Stewart (1717–85), the professor of mathematics. To Edinburgh in 1768 came the farmer–manufacturer–naturalist James Hutton (1726–97), to devote himself to scientific pursuits and to gain for himself a place among the giants of the heroic age of geology. These famous men were afterwards joined by John Playfair (1748–1819), preacher, writer, geologist and natural philosopher, who introduced the works of the French mathematicians into Scotland; Daniel Rutherford (1749–1819), the professor of botany who discovered nitrogen; and the wealthy landowner Sir James Hall, Bart. (1761–1832), of Dunglass, like Playfair an enthusiastic supporter of Hutton's views and himself the founder of experimental geology. In the whole range of science there were no more admirable characters than Hutton and Playfair. Of Hutton, Geikie wrote: "His character was distinguished by its transparent simplicity, its frank openness, its absence of all that was little or selfish, and its overflowing enthusiasm and vivacity"; while Dugald Stewart in his sketch of Playfair wrote: "Independently, in short, of his high attainments, Mr. Playfair was one of the most amiable and estimable of men: delightful in his manners, inflexible in his principles and generous in his affections, he had all that could charm in society or attach in private".

In Edinburgh in the eighteenth century, as elsewhere, there were clubs and convivial gatherings of writers, artists, lawyers and others, and it was from one of these, the Philosophical Club, formed in 1739, that sprang the Royal Society of Edinburgh, inaugurated in 1782, with John Robison as one of its secretaries. A few years before this, in 1776, Edinburgh had seen the laying of the foundation stone of the observatory on Calton Hill, which has in turn belonged to the City and to the Government and again to the City. It has seen many ups and downs, has often suffered from neglect—even as a Royal observatory—but after being reconditioned was taken over by the Astronomical Society of Edinburgh in 1938 and in October of that year was formally reopened by the late Sir James Jeans. Under the inspiring directorship of Mr. N. S. Matthew, it is now widely used for educational purposes.

Edinburgh's first official astronomer appears to have been the naval surgeon Dr. Robert Blair, who in 1783 was appointed professor of practical astronomy. His appointment came about in a very unusual manner. In 1782 Blair was serving in the West Indies in H.M.S. *Resolution*, in which on January 23, 1782, Captain Lord Robert Manners died of wounds received some months before. Now Manners was a son of the famous Marquess of Granby who had fought at Culloden, and a brother of Charles Manners, fourth Duke of Rutland, who was well known in government circles. Blair's devotion to his captain becoming known, the family, wrote Dr. John Doran in his "Memories of our Great Towns", "With generous alacrity importuned the Government to do something for him, and at their solicitation the Crown actually founded for Blair a Professorship of Practical Astronomy in the University of Edinburgh! The naval surgeon and physician had seen enough of the stars to know Orion's belt from Charles' Wain; but had he been ignorant of both it would not have much mattered, as the Astronomical Professorship was a sort of nominal office, without any charge. But if Dr. Blair was not a practical astronomer he was an experimental philosopher of great repute and his experiments and observations on the refrangibility of light excited considerable interest in his own

day. . . ." Blair continued to hold his office until his death on December 22, 1829, at Westlock, Berwickshire. For a few years after this, the chair of astronomy remained vacant, but in 1834, shortly after his return home from South Africa, Thomas Henderson (1798–1844), the advocate's clerk who had risen to be the Astronomer Royal at the Cape, was appointed to it, and about the same time was given charge of the Calton Hill Observatory and made Scotland's first Astronomer Royal. Henderson's immediate successor was Charles Piazzi Smith (1819–1900), who was born at Naples and had the Italian astronomer Giuseppe Piazzi as his godfather, and he in turn was followed by Ralph Copeland (1837–1905), who superintended the building and equipment of the new Royal Observatory at Blackford Hill, made possible by the generosity of the Earl of Crawford.

Of greater importance to learning in Edinburgh than the erection of the Calton Hill Observatory was the building of the "New College of Edinburgh", the foundation stone of which was laid in the fateful year 1789. Unlike those of Glasgow, St. Andrews and Aberdeen, the University of Edinburgh owed nothing to bishops and popes, for its original college was opened by the Town Council and given university status by James VI, afterwards James I of England. Its constitution differed from those of the other universities, and in many matters, even in the appointment of professors, the Town Council held the control. This lasted until the University gained its independence by statute in 1858. The new College was not erected before it was needed, for its principal, the historian William Robertson, had written in 1768 that "a stranger when conducted to view the University of Edinburgh might, on seeing such courts and buildings, naturally enough imagine them to be almshouses for the reception of the poor . . ."; while twenty years later, a writer in the *Scots Magazine* said that "the buildings of the University are in the same ruinous condition that they were in 1768 and the most celebrated University at present in Europe is the worst accommodated".

With the completion of the new College fresh faces appeared among the staff, and the lecture rooms became even more crowded. Black's death in 1799 had left open the way for his deputy, the botanical professor's son, Thomas Charles Hope (1766–1844), who had held the chair of chemistry at Glasgow and had learnt something of the new chemistry direct from the lips of Lavoisier and Berthollet. For forty-three years he lectured and experimented, and it is recorded that at one time his students numbered 575, while the total number who had listened to him was something like 16,800. There was nothing like this in the English universities. His famous colleague, John Leslie (1766–1832), who was born in the same year as Hope, had abandoned a career in the Church for science, had travelled on the Continent and in the United States and had become known for his experiments in radiation before succeeding Playfair in 1805 in the chair of mathematics, which he exchanged for that of natural philosophy in 1819. His first appointment, owing to something he had said about cause and effect, led to an unfortunate controversy, in the course of which Sir Joseph Banks, the president of the Royal Society, wrote to Leslie sympathizing with him and adding: "Surely a man may fulfil his duty to his Creator without assenting unconditionally to every undigested tenet which our half-informed predecessors have left behind as a legacy to their more enlightened posterity. If it has pleased God to permit his creatures to increase in wisdom He will not condemn them for assenting to new opinions which their reason demonstrates to be just." Leslie was knighted at about the same time as Brewster, John Herschel and Charles Bell, and died on November 3, 1832. It was some time before the youthful James David Forbes (1809–68) was appointed to succeed him, and for a few months the natural philosophy lectures were given by John Scott Russell (1808–82), afterwards a famous naval architect. Another of the new professors was William Wallace (1768–1843), who held the chair of mathematics from 1819 until his retirement in 1838, when the Town Council paid Cambridge a compliment by choosing as his successor the Rev. Philip Kelland (1808–79), a Somerset curate's son who had been senior wrangler and first Smith's prizeman. Kelland proved unequalled as a teacher, and he died while president of the Royal Society of Edinburgh.

In such a sketch as this it would be only proper to include a mention of some of the famous Scottish inventors and engineers of the time, such as Watt, Telford and Rennie; William Murdoch, Sir William Fairbairn and James Nasmyth; Henry Bell and William Symington, the pioneers of the steam boat; the Napier family of marine engineers and the Stevenson family of lighthouse builders, but space does not permit more. In view, however, of the approaching meeting of the British Association in Edinburgh, it is only appropriate to conclude by recalling the part played by Scottish men of science in its formation.

The story of the British Association was told in its official history published in 1921; but many more details are to be gleaned from such works as the "Home Life of Sir David Brewster" (1869), "The Life and Letters of James David Forbes" (1873) and other memoirs. It was Brewster and Forbes together with John Robison (1778–1843), the wealthy son of the natural philosopher, and the soldier–administrator–astronomer Sir Thomas Makdougall Brisbane, Bart. (1773–1860), who were prominent in founding the Association; and they were among the Scottish contingent who, with their English and Irish supporters in September 1831, by coach or chaise, on horseback or foot, converged on York for the inaugural and epoch-making gathering. At York the founders received a warm welcome from the Yorkshire Philosophical Society, finding in the keeper of its Museum, John Phillips (1800–74), a most willing secretary; in the Rev. William Vernon Harcourt (1789–1871) a far-sighted vice-president, and in his father, the Archbishop of York, a graceful host. From the Archbishop's Palace at Bishopthorpe, at one in the morning of September 30, after a lecture by Scoresby on magnetism, Brewster wrote that "the assemblage of beauty, fashion, and philosophy was really splendid . . .", while "the Archbishop has invited fifty or sixty of the philosophers to dine here to-morrow, among whom are Sir T. Brisbane, Thos. Allan and the rest of our Scotch party. . .".

In 1832 the newly formed Association met at Oxford and in 1833 at Cambridge; and then, largely through Forbes, at Edinburgh with Sir Thomas Brisbane as president and Robison as local secretary. Some supporters had suggested Dublin, but Forbes would have none of this and wrote to Brisbane in 1833: "It appears to me that it is little short of the duty of the Royal Society [of Edinburgh] to convey to the meeting of the British Association an invitation to make Edinburgh the place of their next meeting. . . . It has always been considered that the origin

of the Society was in a great measure Scottish, and Sir D. Brewster, Mr. Robison and yourself have always been looked upon as its founders. . . ." A copy of this letter he sent to Sir Roderick Murchison, saying: "My dear friend, you are a Scotsman, and though a deserter, you should not quite desert what is due to your country. Only look back and remember what Scotland did for the Association. . . ." Forbes had his way. The meeting was successful and he had the pleasure of entertaining Whewell, Peacock and Vernon Harcourt, of the last-named of whom he wrote, "I learn every year to look with more admiration and affection on that remarkable man". Brisbane, whose name is perpetuated by the capital of Queensland, it may be added, died at his birthplace, Brisbane House, Largs, at the age of eighty-six, and Brewster died at the same age at Allerly, Melrose, but Forbes died at Clifton at the age of fifty-nine. Forbes's grave is in the Dean Cemetery, Edinburgh, and that of Brewster in the grounds of Melrose Abbey.

RESEARCH IN OCEANOGRAPHY

THE sea, covering as its does three-quarters of the surface of the earth, presents unnumbered problems to whet intellectual curiosity and adventure, while economic and utilitarian motives for its scientific study are also pressing. Marine biology has always been actively pursued; in earlier days largely by amateurs and latterly by professionals at a number of well-equipped and well-staffed marine laboratories. Since zoology cannot be studied without regard for marine species, the universities of Britain have always fostered and, no doubt, always will foster, marine research on a considerable scale. Fewer botanists have found such interest in the plants of the sea. Economic stimulus has stimulated investigation of the shore seaweeds, and a research association now exists for this purpose alone.

Fundamental marine zoology has found its economic counterpart in fisheries research undertaken by the Laboratories at Lowestoft and Aberdeen, both full of vigour and ideas. These laboratories have had to study not only fish but also the food of fish and the waters which nourish and transport it. Study of the invertebrate fauna of the sea and the sea bed is in a healthy state; so is the physical and chemical study of the waters which fill the shallow seas frequented by fishing vessels. A re-deployment of effort is in progress; more hands would provide quicker results, but, in relation to the scientific man-power of the country, the staff available, especially in quality, is reasonable.

The Antarctic has become one of the best known of the major oceans by the tireless work of the Discovery Committee and its ships and staff, the contributions of which both to marine biology and to physical oceanography have been great. None the less, the motive for all their work has been economic—to provide a scientific foundation for the whaling industry. There have been huge fields of physical investigation which were neither proper for their study nor could they be undertaken with their limited staff. The entire expenses of the Discovery Committee have been met by the Government of the Falkland Islands from a cess levied on all whales processed in the Falklands or their territorial waters. Great Britain's contribution has been a negative one—revenue derived by taxation of the staff who live here.

Investigations to secure safer navigation have always been and remain the concern of the Hydrographer of the Navy. There was a time when the British Hydrographic Office unaided charted the seas of all the world. To-day the Admiralty's fleet of survey ships forms only a part of the survey fleet of the world, but the quality of its work ranks as high as ever. Tidal investigations flourish both at the Admiralty and at the Liverpool Tidal Institute, the annual report* of which has just been published.

Theoretical investigations of much importance, especially in hydrodynamics, have been made by a few gifted free-lances in the universities, but physical oceanography has been ill organized. Apart from nuclear physics, oceanography is probably the most expensive of all scientific techniques, so that there has been little opportunity for experimental physical investigation or for deep-sea research. Submarine geology and geophysics are in the hands of a few men at a single university, who have had to borrow ships when needed as best they could.

At a meeting of the Scientific Advisory Committee of the War Cabinet in January 1944, Vice-Admiral Sir John Edgell, then Hydrographer of the Navy, expressed the view that Great Britain, in its contribution to research in oceanography, had fallen seriously behind other countries, and suggested that a British oceanographical institute should be set up without delay. Inquiry showed that there was a considerable body of opinion in favour of concentrating the efforts upon physical studies, which had been neglected as compared with marine biological research. However, the Scientific Advisory Committee considered that the work of the proposed institute should embrace both physical and biological oceanography. In July 1946, the Colonial Office raised the question of the future of the Discovery Investigations. This matter was considered by various government departments interested and by the Advisory Council on Scientific Policy in conjunction with the earlier proposals, and as a result the National Oceanographic Council and the National Institute of Oceanography came into being (see *Nature*, March 17, p. 415). The steps leading to the formation of the Institute are indicated in its first annual report†.

The National Institute, with Dr. G. E. R. Deacon as first director, has taken over the Oceanographic Group of the Royal Naval Scientific Service at the Admiralty Research Laboratory at Teddington, and also the Discovery Investigations, which had ceased to be the responsibility of the Falkland Island Dependencies on March 31, 1949; the Institute is also gradually taking over part of the work of the Oceanographical Branch of the Hydrographer of the Navy. The R.R.S. *Discovery II* and R.R.S. *William Scoresby* were purchased by the Admiralty from the Government of the Falkland Islands Dependencies and presented to the Institute. The shore work of the Institute remains dispersed among five establishments in the London area and one in Cornwall. The very desirable concentration under the director in one place remains to be achieved.

Both the research vessels were under requisition during the War, and their equipment in store was destroyed by enemy action. Both ships have needed extensive refitting and re-equipment before resuming

* Liverpool Observatory and Tidal Institute: Annual Report, 1950. Pp. 16.

† Annual Report of the National Institute of Oceanography 1949–50. Pp. 48. (Cambridge: At the University Press, 1951.) 5s. net.

the Discovery Committee's programme in the southern hemisphere. R.R.S. *William Scoresby* was first to sea in January 1950 and proceeded to survey the Benguela Current off the coast of south-west Africa. It can be seen already that much information of first importance on the physics and chemistry of the current and on its faunistic content was obtained, and that the resources of the Institute will be strained to evaluate and publish the results in reasonable time. This ship also carried out fishing experiments in South African waters, some whale-marking and a considerable amount of work on the Agulhas Current before returning to England last autumn.

The larger R.R.S. *Discovery II* put to sea in May 1950 and proceeded to the southern hemisphere to undertake investigations on the lines of those between the Wars, but at seasons and in parts of Antarctic and Australasian waters previously least investigated. There was also a considerable number of other programmes for investigation. She is still at sea, but it is clear already that she will return prepared to add much to knowledge. The sea programme of the Discovery Committee will then have been completed. The working up of the vast faunistic collections must continue for many years. Similarly, the complete evaluation of the chemical and physical observations by the two ships at about four thousand stations during twenty years will require much effort.

The work on waves, swell, microseisms and currents initiated at the Admiralty Research Laboratory is being continued by the Institute. Although the main object of the wave research is to obtain quantitative information about the factors which influence the generation, propagation and decay of waves, such as will allow the wave conditions at any place to be predicted from wind charts and a knowledge of the local hydrography, the techniques which have been developed have immediate applications in places where meteorological information is not available. Such a possibility is being considered for Mauritius, where there is need of warning of the approach of a cyclone or heavy swell over the off-lying shoals used by local fishermen.

Modern oceanography demands larger ships, manned by officers and crew well versed in their specialized duties. The experience of the Discovery Committee, shared by the marine laboratories, is that it takes time to select and train such staffs and that it is a tragedy if key personnel have to be dispersed when a ship has to be laid up. But the larger ships have the capacity of collecting at a great rate. Even under the most favourable conditions, it will take a man ten weeks to work up observations which he can collect in one. Yet it would seem that the two vessels will have to be kept at sea and their collections and results appreciated, and the parallel laboratory investigations continued, by a staff of no more than sixteen scientific and six experimental officers. If these valuable, but expensive, ships are to be put to best use, a very considerable recruitment of staff would seem necessary.

In most fields of marine study the days of collecting for the sake of collecting are ended. The museums are stuffed with millions of specimens and station lists with hundreds of thousands of observations, woefully inadequate to give a true picture of the ocean it is true, but beyond the capacity of the systematists and physical oceanographers of Great Britain or, for that matter, of the world to work up. Support is more readily obtained for dispatching a spectacular expedition than for the quiet working up of the results afterwards or for their publication. An adequate theoretical background and due selection of problems for work at sea is now possible and can lead to great economy. There is no doubt but that the National Institute of Oceanography under its present director will seek to achieve this.

Cost of publication everywhere presents a grave problem often met by the compression of papers to the point of incomprehensibility. In chemistry the high reproducibility of experimental results and standardization of techniques may make possible compression intelligible to the initiated, but not so in oceanography. In the sea the same situation never repeats itself and, the cost of getting observations being what it is, each one has to carry all the interpretation it can bear. The cost of the many necessary illustrations is now very high, and it seems less easy to get the relatively small funds for publication than for the prosecution of the actual research. May one hope that the Institute will be able to maintain the high standard of presentation of Discovery Reports ?

Great Britain should be grateful that the creation of the National Institute of Oceanography has been courageously tackled and that investigations are proceeding on a wide front. It should get good value for the annual grant of £115,000 which departments of the home Government and certain Dominion Governments are providing. L. H. N. COOPER

BRITISH INSTRUMENT INDUSTRIES' EXHIBITION

THE Exhibition of the British Instrument Industries, which took place during July 4–14, in the National Hall, Olympia, London, owed its inception to a suggestion made by the Department of Scientific and Industrial Research. Some two years ago, the Department put forward the suggestion that it might be helpful and instructive to industry if an exhibition could be staged at which equipment, covering the entire range of industrial instrumentation, could be displayed and its use demonstrated. This suggestion was put before a meeting of interested trade associations who, while accepting the Department's recommendation, felt that the scope of the Exhibition should be extended to include the products of the whole field of British instrument manufacture, covering every variety of the use of instruments. This wider conception provided the background of the Exhibition which has recently concluded, and the successful achievement of these aims has been an event of unusual significance in the long history of instrument-making in Great Britain.

There has been a tendency for instrument interests to become sectionalized, according to the broad uses of various classes of instruments, and the five participating trade associations (British Electrical and Allied Manufacturers' Association; British Industrial Measuring and Control Apparatus Manufacturers' Association; British Lampblown Scientific Glassware Manufacturers' Association; Drawing Office Material Manufacturers' and Dealers' Association; and the Scientific Instrument Manufacturers Association of Great Britain, Ltd.) have emerged as representing groups of manufacturers of instruments having certain specific fields of use, although the last-named association, S.I.M.A., covers instrument

manufacture of great diversity. One reason for the special significance of the Exhibition is to be found in the fact that it involved a major co-operative effort on the part of these Associations, and demonstrated that the common ground of instrument manufacture is of sufficient extent both to permit co-operative effort and to render it highly desirable. The Exhibition has, therefore, served an excellent internal purpose, since it may well have checked a tendency for the total effort of instrument manufacture in Great Britain to be hampered by excessive emphasis being placed on sectional differences. There has, in the past, existed some confusion among the users of instruments in regard to methods of approach to the industry, and it is to be hoped that the common effort which has now been made may lead to a more unified system of access.

The Exhibition was also significant in its comprehensiveness. Previously, there have been displayed at various industrial exhibitions instruments peculiarly relevant to particular industries: a rather wider display of instruments has been staged at the British Industries' Fair; and in the very noteworthy exhibitions of the Physical Society the emphasis has been on instruments of immediate scientific interest. This most recent Exhibition of instruments, however, has given, for the first time, a complete picture of instrument manufacture in Great Britain, and has provided an opportunity of assessing the extent to which the extremely diverse and widespread requirements for instruments are being met by the range of products of the instrument industries. The display of instruments at Olympia gives solid grounds for the belief that instrument makers in Great Britain are, in general terms, adequately fulfilling their tasks, and that the diversity of requirements for instruments is being matched by an equal diversity and a commendable ingenuity of production.

Of the Exhibition itself it should be said that it was admirably staged. It was, naturally, a specialist exhibition, and it was not to be expected that the Hall would be thronged with people; one of the most pleasing features of the Exhibition was the genuine interest in instruments and their use which characterized almost every visitor. The area devoted to the exhibits was of an extent which allowed ample gangway space, and the lack of fatigue usually associated with a tour of an exhibition was quite exceptional. The organizing authorities are to be congratulated both on the general lay-out of the Exhibition and on the achievement of a very marked impression that this was indeed a display of very special products.

The diversity of instrument types is such that it would be impossible, and would serve no useful purpose, to give in any detail an account of the actual instruments which were displayed. A conspectus of modern instruments, such as that provided at Olympia, does emphasize the manner in which the use of instruments has been extended and entirely changed in emphasis during the past generation or two. It is not so long ago that Lord Kelvin devised electrical instruments specifically for use in the application of science rather than in the pursuit of fundamental knowledge. To-day, the majority of electrical instruments are designed to meet the requirements of the great electrical industry, and the need for precise electrical measurements in so many industrial and civil activities. Many visitors to the Exhibition must have remembered the time when such principles as those of thermo-electricity and hydrodynamics were little known and little used outside the curricula of universities. The control of all industrial processes to-day is dependent upon the concrete application of these and other principles in the form of instrument devices. The provision of complicated scientific glassware was, at one time, only achieved through the skill of individual glass workers here and there, who served, almost entirely, individual laboratories. From the display at Olympia it is apparent that scientific glassware of the utmost intricacy can be obtained by routine ordering through the appropriate section of the industry. Much of the time of the research worker used to be taken up in improvisation and the devising of particular apparatus necessary to the prosecution of his investigations. To-day, instruments are available which will fulfil practically every research need, and the days of almost complete dependence upon the laboratory workshop are largely a memory. In an entirely different field, the set-square, ruler and dividers have been supplemented by a whole series of drawing-office devices, and both the preparation and reproduction of drawings and blueprints have been revolutionized. It is realized to-day that full productivity is dependent upon the provision of the tools most appropriate to each field of endeavour, and it is equally apparent that effective activities in science, whether they be in the acquisition of new knowledge or in the application of knowledge to utilitarian purposes, require that there shall be available the requisite and appropriate instrumental aids. The Exhibition at Olympia has demonstrated that the range of such aids emanating from British instrument industries is most satisfactory in its comprehensiveness.

It must be obvious to any observer with an intimate knowledge of industry that the proportion of effort covered by research and development in the production of scientific instruments is abnormally high. There is frequently heard a complaint that a particular type of instrument with certain peculiar features is not available from any British manufacturer, whereas it can be obtained from some other country. It is, of course, equally true that in other countries the complaint is made that particular types of instrument with peculiar characteristics can only be obtained from Great Britain. While, superficially, it might appear to be desirable that every conceivable instrument or device should be produced by the instrument makers in Great Britain, yet it should be remembered that instrument-making is no more free from economic considerations than is any other industrial undertaking. There is much to be said for the view that it would, in fact, be a retrograde step if the instrument makers of every country attempted to produce every variety of instrument which can possibly be required by the scientific workers of that country, irrespective of considerations of the total universal demand for any one type. It is apparent that the instrument industries of Great Britain have attempted to meet, as completely as possible, the general requirements for instruments. Too often the magnitude of the achievement of the instrument maker is minimized through a sense of irritation caused by an inability to obtain from any maker an instrument exactly suited to a small but specialist use. It is very doubtful whether an extensive range of instruments, such as has been shown at Olympia, could have been made available had the instrument industries not been compelled, by economic necessity, to maintain a sense of proportion in their manufacture.

NEWS and VIEWS

Plant Industry in Australia: Dr. O. H. Frankel

Dr. O. H. Frankel has been appointed chief of the Division of Plant Industry, Commonwealth Scientific and Industrial Research Organization, Canberra. Dr. Frankel has had wide experience in the botanical field and has made outstanding contributions as a geneticist. He has been on the staff of the Department of Scientific and Industrial Research, New Zealand, since 1929. He was appointed first as a geneticist at the Wheat Research Institute, and later became chief executive officer of the Institute; more recently, he has been director of the Crop Research Division of the Department. A British subject by naturalization, Dr. Frankel was born in Vienna in 1900. He holds the degrees of doctor of agriculture of the University of Berlin, and master of agricultural science and doctor of science of the University of New Zealand. Dr. Frankel and his co-workers at the Wheat Research Institute have succeeded in breeding wheats which are suited to the unfavourable New Zealand environment and yet which combine the desirable properties of high yield and high quality. Thus New Zealand farmers can now grow wheats suitable for high-quality bread-making, whereas previously their wheats produced only low-grade biscuit flour.

Technical Personnel Committee

In a written answer to a question in the House of Commons on July 26, Mr. Alfred Robens, Minister of Labour and National Service, said that it has been decided to reconstitute the Technical Personnel Committee, which, under the chairmanship of Lord Hankey, dealt with questions of scientific and technical man-power during the Second World War and during the immediate post-war period.

The terms of reference of the Committee are: (1) To consider, make recommendations and deal with questions relating to the home and overseas demand for the available supply of scientific and technical personnel of professional or approximately professional standards, including the making of recommendations on its economic use and the need for increasing the available supply. (2) In connexion with the overseas demand for such personnel: (*a*) to make recommendations upon appropriate steps to promote the recruitment from the United Kingdom of persons required to assist the economic development of under-developed countries; (*b*) to consider any special steps which are required to provide opportunities for training in the United Kingdom of persons from under-developed countries. The Committee will be empowered to invite representatives from other Government departments or outside interests to be present when matters of concern to them are being discussed.

The membership of the reconstituted Committee is as follows: Chairman, Lord Hankey; members nominated by the Federation of British Industries, Sir Arthur Fleming, Sir Wallace Akers, and Captain A. M. Holbein; representative of the Universities, Sir Edward Appleton; chairman of the University Grants Committee, Sir Arthur Trueman; deputy chairman of the Advisory Council on Scientific Policy (nominated by the Lord President), Prof. S. Zuckerman; one representative each of the Treasury, Foreign Office, Colonial Office, Board of Trade, Commonwealth Relations Office, Ministry of Labour, Ministry of Supply, and Lord President's Office. The secretary will be Mr. A. J. S. James, Ministry of Labour and National Service.

Productivity of British Land

A Sub-Committee of the Research Committee of the Rural Reconstruction Association has published a report on "The land which would be required to produce the food requirements of Great Britain and Northern Ireland on the basis of present yields of crops and livestock". The Committee has taken the consumption of food in 1946 as a year when the diet was adequate and of which accurate estimates exist. By taking each of the main items in the diet it worked back to the land which would be required for total production, which was found to be 49,553,000 acres of crops and grass, whereas the total actually available is only 35,530,000, plus some nine million acres of rough grazing. It is thus concluded that Britain could feed herself if the average annual yield of crops could be increased by about 40 per cent. Alternatively, the calculations show that the target of the Ministry of Agriculture of 55 per cent home production of essential foods is modest. The report has very interesting appendixes on land requirements for poultry, cattle and pigs. The Committee in its calculations suggests that a much greater proportion of the meat requirements should be obtained from pigs and that if five million acres of cropland were devoted to production of pig foods the number could be increased to about 16 million, providing nearly 60 per cent of the estimated meat consumption. The report is one which deserves careful study.

Scottish Hill Farm Research Committee: First Report

The first report of the Scottish Hill Farm Research Committee of the Scottish Advisory Council has now been published (pp. 134+16 plates; Edinburgh and London: H.M. Stationery Office, 1951; 3*s.* 6*d.* net). Set up in 1945, this Committee was appointed to advise on the development and co-ordination of research in relation to technical problems of hill farming in Scotland. Three research farms have been established, each affording facilities for different types of investigation. At Sourhope, Roxburghshire, the management of grass hills is the dominating question; at Glensaugh, Kincardineshire, wintering problems are under consideration; and at Lephinmore, Argyll, the co-ordination of hill farming with forestry is being studied. The work carried out during 1945–49 is reviewed in detail. Among the interesting questions investigated is the possibility of applying fertilizers to hill land by means of aeroplane. Preliminary trials indicate that satisfactory distribution of lime can be effected in this way, but that reduction in costs is essential before the method can become an economic proposition. Problems concerned with sheep naturally form a major part of the agricultural research work in Scotland, and co-ordination of field trials regarding sheep-dips has been attained and a survey made of the breeding systems used in hill flocks. Various diseases cause unnecessary loss, and the Committee emphasizes the need for extension of the veterinary service. Special attention has been paid to heather. A review of the literature on the subject is included in the report, and recommendations made as to profitable lines of work to be undertaken with regard to this valuable plant. A new Committee to continue in office for a three-year

period was set up in 1949. Among other activities, its programme will include economic studies and detailed surveys of the districts in which the three experimental farms are situated.

Reviews of Pure and Applied Chemistry

The first issue of *Reviews of Pure and Applied Chemistry*, published by the Royal Australian Chemical Institute, Melbourne (quarterly, £1 5*s*. a year), will be welcomed by chemists in Australia, but should prove of interest to a much wider circle of readers. The facilities for the publication of original researches in Australia are now quite well served by many journals, and the decision of the Institute to start a review journal is very sound. According to the opening editorial, the aim is to provide "a journal in which general articles and critical reviews in all branches of chemistry could be published". The contents of the first issue include a discussion of the mechanism of chemical change by Prof. F. G. Soper and an article dealing with the impact of chemistry on biology and medicine by Prof. A. R. Todd; the chemical engineering problems in the generation of nuclear power are outlined by Prof. J. P. Baxter, while Dr. K. L. Sutherland has reviewed the change of surface tension with time. Clearly the aims of this journal are different from those of either *Chemical Reviews* or *Quarterly Reviews*, since, if the first number reflects future policy, articles as well as detailed reviews receive equal prominence. Undoubtedly the more general articles, as well as the detailed reviews, will be welcomed by the members of the Institute, who vary from the pure research worker to the wholly administrative chemist. However, it should be appreciated that some articles are by no means as comprehensive or as detailed as those to be found in the two review journals quoted above. The editor rightly rejects any purely nationalistic objective in the inauguration of this journal; nevertheless, it is to be hoped that readers throughout the world will be able to look to it for periodical reviews of work in those branches of chemistry in which certain Australian schools are most active. The printing is good, and the diagrams are well reproduced. Within the limits which have been laid down, *Reviews of Pure and Applied Chemistry* has made a good start.

Bulletin of the Research Council of Israel

The *Bulletin of the Research Council of Israel*, the first number of which has recently been published (1, Nos. 1–2; pp. 168; March 1, 1951; Jerusalem; annual subscription (4 issues) £I 2; single copy 500 prutot, double number 750 prutot), is intended primarily to facilitate the publication of scientific papers dealing with problems of regional importance but of wider interest. In addition, preliminary communications on both fundamental and applied research will be accepted in the form of letters to the editor, and the present issue contains forty-one such letters. The nine papers included deal with such varied subjects as the geomorphogeny of Israel; long-range forecasts of rainfall; the formation of 'salt tables' in natural and artificial solar pans; the iodine number estimation of bitumen; the vegetation of the Kurkar Hills; egg-development and diapause in the Moroccan locust; estimation of the incidence and destructiveness of plant diseases (terminology and outline of the technique of visual appraisal); fractionation of whey proteins as a means of grading milk powders and detecting adulteration of fresh milk with milk powder; and investigations on *d*-limonene, a by-product of the citrus industry. It is intended in future to publish four numbers annually.

Bibliography of French Mathematics and Astronomy during 1940–48

The December 1950 issue (No. 6) of the *French Bibliographical Digest* (pp. 109; New York: Cultural Division of the French Embassy, 1950) lists the most significant books on mathematics and astronomy published in France during 1940–48, together with some works published in French by Belgian and Swiss men of science. Only works of at least university level are included; but special courses on higher mathematics given at French universities and college text-books of special interest are regarded as meeting this requirement. Some reviews which have been taken, with acknowledgment, from *Mathematical Reviews*, *Revue Générale des Sciences*, *Revue Scientifique* and the *Bulletin Critique du Livre Français* are included, and the books are listed alphabetically by authors' names in classified sections under mathematics and under astronomy. Prof. Arnaud Denjoy contributes an appreciation of French mathematics during the Second World War, and besides an index of authors and collective works there is a list of French periodicals dealing with these fields of science and a directory of publishers.

Bengal Immunity Research Institute, Calcutta

A pamphlet has been published by the Bengal Immunity Research Institute, Calcutta, on the occasion of its third anniversary on November 26, 1950, describing the origins and organization of the Institute. Research in medicine, chemistry, biochemistry, biology, physiology, bacteriology, therapeutics, materia medica, pharmacy and other subjects which bear upon the prevention, alleviation and cure of human diseases and disorders, is carried out. The Institute also seeks to develop new medicaments, to improve existing processes and products; it collaborates in the investigations on drugs at the Bengal Immunity Therapeutic Ward; and it organizes lectures and demonstrations. The research programme is scrutinized by a scientific advisory board. The number and character of the departments of the Institute are elastic: departments of bacteriology, biochemistry, chemistry and pharmaceutical chemistry and of pharmacology have been established, as well as a museum to accommodate specimens of Indian medicinal plants and their active principles, and a library containing more than six thousand volumes. The Institute has already published nearly five hundred papers.

Safety in the Laboratory

A manual on safety in the laboratory prepared by the Dunlop Rubber Co., Ltd., primarily for the guidance of its own technical staff, contains some excellent advice and information which will be found useful by all laboratory workers. It emphasizes that safety is largely a matter of exercising forethought and reasonable care. General safety policy, fire and first aid, and a safety code for laboratory practice are the headings of the three sections into which the manual is divided. An appendix deals with electrical procedure in laboratories. The safety code lists the various items and the appropriate precautions to be taken, as, for example, "Cathode ray tubes—wear eye-shields when handling cathode ray tubes in case of implosion", in alphabetical order. Messrs. Dunlop

are to be congratulated on the way in which they have tackled the vital problem of safety in the laboratory and for making such excellent provision against laboratory and technical hazards.

Northampton Polytechnic

DR. P. F. SOPER, head of the Electrical Engineering Department of the Nottingham and District Technical College, has been appointed head of the Electrical Engineering Department of the Northampton Polytechnic, St. John Street, London, in succession to Dr. J. S. Tait, who has been appointed principal of the Woolwich Polytechnic. Mr. K. J. Hume, at present metrology superintendent of the De Havilland Engine Co., Ltd., has been appointed head of the National College of Horology and Instrument Technology (which is housed in the Northampton Polytechnic) in succession to Mr. R. A. Fell, who is returning to industry.

Medical Research Council : Travelling Awards

THE Medical Research Council has made the following travelling awards for the academic year 1951–52 : Rockefeller Travelling Fellowships in Medicine : Mr. W. Burnett, surgical registrar, Professorial Unit, Aberdeen Royal Infirmary ; Dr. O. Garrod, outpatient registrar and medical tutor, Postgraduate Medical School of London ; Dr. J. N. Hunt, senior lecturer in physiology, Guy's Hospital Medical School, London ; Dr. G. C. Kennedy, temporary member of staff, National Institute for Medical Research, London ; Dr. B. P. Marmion, senior bacteriologist, Public Health Laboratory Service (at the Virus Reference Laboratory, Colindale) ; Mr. J. H. Peacock, lecturer in surgery, University of Bristol ; Dr. S. W. Stanbury, Junior Beit Memorial Research Fellow, Department of Medicine, University of Manchester ; Dr. E. M. Vaughan Williams, Schorstein Research Fellow in medical science, Department of Pharmacology, University of Oxford. Dorothy Temple Cross Research Travelling Fellowships in Tuberculosis : Mr. R. W. Baldwin, research assistant, Chemistry Department, University of Birmingham ; Dr. G. J. Cunningham, senior lecturer in morbid anatomy and histology, St. Bartholomew's Hospital Medical College, London. Travelling Scholarships in Medical Science (tenable in France under an exchange scheme with the Centre National de la Recherche Scientifique) : Mr. S. V. Boyden, Wellcome Fellow of the Animal Health Trust, Department of Animal Pathology, University of Cambridge ; Dr. J. L. Gowans, Medical Research Council research student, Sir William Dunn School of Pathology, University of Oxford.

Colonial Service : Recent Appointments

THE following appointments in the Colonial Service have recently been announced : G. W. Lines (deputy director of agriculture, Sierra Leone), director of agriculture, Sierra Leone ; E. H. Probyn (assistant conservator of forests, Cyprus), senior assistant conservator of forests, Cyprus ; J. S. Smith (senior assistant conservator of forests, Cyprus), conservator of forests, Federation of Malaya ; J. H. Keast (senior surveyor, Nigeria), assistant director of survey, Nigeria ; R. N. Lissett (senior surveyor, Tanganyika), senior surveyor, Uganda ; T. W. Wignall (senior surveyor, Gold Coast), surveyor general, North Borneo ; J. S. Dunbar (draughtsman, Geological Survey Department, Tanganyika), chief draughtsman, Geological Survey Division, Tanganyika ; Miss L. M. Horne (woman nutrition officer, Trinidad), woman nutrition officer, Windward Islands ; M. J. Jacovides (forest assistant, Cyprus), assistant conservator of forests, Cyprus ; S. D. Watson (draughtsman, Lands and Mines Department, Tanganyika), chief draughtsman, Surveys and Town Planning Department, Tanganyika ; J. Heathcote, education officer (science), Kenya ; J. F. Cowie, veterinary officer, Uganda ; R. G. Erskine, veterinary officer, Nigeria ; G. A. Currie, statistician, East Africa High Commission ; W. J. England, principal, Egerton School of Agriculture, Kenya ; S. A. Granville, statistician, Statistics Department, East Africa High Commission ; A. M. Hobdey, temporary agricultural survey officer (cocoa), Gold Coast ; R. R. Philp, soil survey officer (temporary), Gold Coast ; P. D. Proud, fisheries officer, Aden ; S. A. Radwanski, soil survey officer (temporary), Gold Coast ; W. Rides, temporary agricultural survey officer (cocoa), Nigeria.

Announcements

THE honorary degree of D.Sc. of the University of Oxford has been conferred on Dr. G. G. Simpson, of the American Museum of Natural History, New York.

THE Royal College of Physicians has awarded the Weber–Parkes Prize to Dr. P. M. D'Arcy Hart, for his contributions to the epidemiology and prevention of tuberculosis ; and the Baly Medal to Prof. G. de Hevesy for his work on radioactive indicators and their application in biochemistry, animal physiology and pathology.

THE Committee representing the Royal Society and the University of Sheffield has appointed Dr. B. A. Bilby as Sorby Research Fellow from October 1, to work in the Metallurgy Department of the University of Sheffield on martensitic transformation and deformation twinning in crystals. The Committee representing the Royal Society and the Armourers and Brasiers' Company has appointed Dr. A. J. Kennedy as Armourers and Brasiers' Company Research Fellow from October 1, to work at the Royal Institution of Great Britain on transient creep in polycrystalline metals.

THE Royal Society has arranged a 'Sir Isaac Newton' Exhibition on the occasion of the Festival of Britain. The Exhibition will be held during August 13–31 from 11 a.m. to 4 p.m. (except on Saturdays and Sundays) in the Society's rooms, Burlington House, London, W.1. Admission will be free.

THE Parsons Memorial Lecture for 1951 will be entitled "Sir Charles Parsons and Optical Engineering", and will be given by Mr. F. Twyman, in the Science Museum Lecture Theatre, on October 25, under the auspices of the Physical Society.

A CONFERENCE on "The Chemistry and Physiology of the Nucleus" will be held at Brookhaven National Laboratory during August 15–17. This conference, which is being organized and sponsored by the Biology Department of the Laboratory, will include eighteen speakers and five demonstrations. It is hoped to publish invited papers. Inquiries should be addressed to the Biology Department, Brookhaven National Laboratory, Upton, L.I., New York.

THIRD WORLD PETROLEUM CONGRESS

WITH nearly three hundred papers from leading petroleum technologists in every oil-producing or oil-refining country, the Third World Petroleum Congress which met in The Hague during May 28–June 6 covered the whole range of the sciences concerned with the petroleum industry—geology, geophysics, engineering in all its branches and chemistry, as well as statistics, documentation and economics.

At least sixty sessions were held and all were well attended. In general, discussion was lively and to the point, being restricted only by the time factor, which was somewhat limited by the time taken to read in two languages the instructions regarding discussion.

Geology and Geophysics. In the session on the origin and migration of oil, when papers were presented by Margaretha Brongersma-Sanders (University of Leyden), by I. A. Breger and W. L. Whitehead (Massachusetts Institute of Technology), and by C. E. ZoBell (Scripps Institute of Oceanography), the consensus of opinion was that there is need for generally accepted definitions and methods of analysis of organic matter occurring in geological formations. This is particularly true for crude oils in relation to migration and classification studies, but also applies to maltha, asphalt, asphaltic, pyrobitumen, etc. The setting up of a committee to study these matters was recommended, and it was suggested that it should consist of Prof. V. C. Illing (United Kingdom), M. Louis (France), G. R. Schultze (Germany), H. M. Smith (United States), and K. van Nes (The Netherlands). It was also resolved that the Permanent Council of the World Petroleum Congress take the initiative in clarifying the terms relating to oil migration.

Several papers on palæontology and sedimentology were discussed in two sessions, an important contribution being that of T. F. Grimsdale, who proposed geological correlation on a world-wide scale. In comparing Venezuelan and Middle East rock sequences of the Tertiary, Mr. Grimsdale uses pelagic (open ocean) foraminifera. From this subsection of the geological section came two resolutions. The first, based on a paper by D. J. Doeglas, stressed the desirability of regional investigations into sedimentary deposits and environments, as proposed in Project 5 of the American Association of Petroleum Geologists; but such studies should not be limited to the Gulf Coast area. The second resolution recorded the opinion that world-wide correlations could be established in the Upper Cretaceous and in the Tertiary formations by means of the pelagic foraminifera.

Regional geology of oilfield areas was the subject of several papers, a session with four papers on the Middle East being concerned mainly with Persia. There were also sessions on Italy, with seven papers, and on Mexico.

In the subsection on geophysics, there were nine papers dealing with seismological, gravitational, and electrical methods.

Drilling and Production. In this section there were about fifty papers covering all aspects of this important branch of the industry. In the session on drilling technique, the papers were mainly devoted to mechanical processes associated with the drilling of oil wells. Two resolutions concerned the standard testing of casing centralizers, and a proposal that the American Petroleum Institute consider standard specifications for integral-joint casing.

Opening the session on drilling, completion and production technique, the chairman pointed out that the papers clearly showed how technique has advanced since the early days of the industry. For several of the papers a considerable mathematical background was necessary.

Discussion on the type of mud used in completing oil wells demonstrated that oil-well performance could be materially improved by choice of the proper drilling fluid. The general opinion was that oil-base muds are equal or superior to oil-in-water emulsion muds, or to normal clay–water muds for well completions, but that water alone is probably the best fluid as far as drilling speed is concerned.

The value of laboratory investigations for the development and improvement of drilling and production technique was evident in the discussion on several papers. Investigations into the properties of the cements used in deep wells were reported in a paper from the Institut Français du Pétrole, and it was recommended that blast furnace slag cements should be used for the purpose. Work on the effect of particle size on the physical properties of drilling mud makes it possible to predict the viscosity of a clay-base fluid for a given concentration of solids, provided particle-size distribution is known.

A new approach to the knowledge of the behaviour of crude oil emulsions was outlined in a paper on a universal size-frequency distribution law for emulsion particles. When water and oil are produced together, their separation causes difficulties in practice. A formula has been derived statistically for describing droplet size distribution and has proved its value also in other oil-industry operations.

The importance of additional recovery from oilfields was pointed out in several papers, and methods of secondary recovery were reviewed. There were also several reports of laboratory investigations. It was also stated that in Digboi notable increases in production-rates have been obtained by washing waxy wells with kerosine. The effect is to soften, rather than to dissolve, wax in and near the well.

Physical Refining Processes. In this section an interesting discussion on calculations in relation to distillation apparatus and information was given from the Polytechnic Institute of Brooklyn of a new laboratory apparatus for the determination of equilibrium flash curves of complex mixtures. This apparatus is a modified type of recirculating equilibrium still, is compact, of low initial cost, and is expected to provide an improved basis for calculations.

Chemical Refining Processes. The session on hydrogenation and hydrocarbon synthesis was attended by a large audience, and discussion centred mainly on the development of synthesis. It seems that vapour-phase processes are likely to receive competition from the liquid-phase processes now being developed. Although fluid-catalyst technique is largely applied in the vapour-phase processes, the fixed-bed process still received much attention. An improved large fixed-bed plant is shortly to come into operation in Germany.

The development in Germany of the one-stage process for destructive hydrogenation of crude oil to gasoline with new catalysts occupied most of the discussion as regards hydrogenation. Combined hydrogenation and catalytic or thermal cracking processes are likely to be used on a large scale in Germany.

In the session on catalytic reforming, an interesting paper was that by E. V. Murphree on a fluid hydroforming process, which is claimed to produce gasoline of improved octane rating. The fluid-process plant was said to cost 40 per cent less than fixed-bed units.

A paper on a new process for the polymerization of gaseous olefins to motor gasoline gave rise to interesting comparisons with the well-established solid phosphoric acid process.

The importance of sulphur removal and recovery from petroleum products was reflected in the five papers in the session on chemical treating processes. Methods for sulphur removal ranged from conventional soda sweetening of gasoline to hydrofining —selective hydrogenation of sulphur compounds. The latter process has attractive prospects.

Petroleum Chemicals. This section was concerned with the properties and the application of petroleum-based chemicals. Thus, in the detergent session, the five papers related to the extraordinary growth of petroleum detergents in the United States, where such materials now account for 55 per cent of the total American production of synthetic detergents. It was clear that the market outside the United States cannot be forecast from American developments, and it appeared that although the alkyl aryl sulphonates lead in the detergent field, alkyl sulphates, when prepared from petroleum, are likely to challenge their position. The influence on detergent properties of the hydrocarbon constitution was specially discussed.

In regard to biocides, it was stated that our knowledge of the chemical and physical compositions of mineral oils is still insufficient to guarantee that a certain oil would be suitable for agricultural use without previous field testing.

Composition of Petroleum. During the discussion of a group of papers on pure hydrocarbons, attention was directed to the fact that international exchange of data on these materials could be improved. It was therefore recommended that the extension of such exchange of research data should be explored. The discussion dealt mainly with the suitability of different criteria for determining hydrocarbon purity, and with the applicability of various physical constants for identifying and analysing hydrocarbons.

Properties of crude oils were considered from two aspects: first, the classification and evaluation of crude oils; and secondly, their commercial evaluation. It was considered that characterizing factors now used do not correlate with chemical composition but mainly summarize the physical properties. It would be convenient, although it did not appear possible, to combine the two aspects into one simple factor. It was concluded that knowledge of the chemical composition of crude oils necessitates a more complicated scheme of analysis, which would require more uniformity in methods of investigation in order to correlate results obtained all over the world.

Ten papers in this section were devoted to various aspects of the constitution of petroleum. The investigation of the complex mixtures of which petroleum fractions are composed has been simplified by modern methods of group analyses. In regard to determination of oil composition by spectrographic analysis, it was considered that the emphasis should be more on so-called type analyses.

Utilization. Papers in this section dealt with the utilization of such petroleum products as engine fuels, lubricants, heating fuels and bitumen.

In the session on gasoline engine fuels, the reduction of engine friction was suggested as an alternative to higher compression ratios in order to reduce fuel consumption. It was also pointed out that there is room for improvement in automatic control of spark advance. In the overall economic picture, increased cost of high-compression engines should be weighed against increased cost of producing higher anti-knock gasoline.

The gas turbine fuel session discussed three aspects of the general subject. First to be considered was the complicated position which exists because the severe cold-test requirement of aircraft turbine fuel specifications limits the supply sources. Opinions varied widely as to the extent to which engine and fuel should contribute to the solution of the problem. Secondly, on the use of boiler-type fuels in stationary and marine gas turbines, the economics are not favourable without a cheap fuel. Difficulties due to varying percentages and composition of ash from the fuel are still serious. Finally, the Pescara system as applied to locomotives was dealt with. In this system a free-piston diesel is combined with a turbine, through which it develops its power and which functions simultaneously as a variable-torque transmission element.

Four papers on motor lubricants all dealt with some aspect of additives; the general comment was that the large amount of research being carried out is insufficiently stressed. It was also suggested that viscosity-index improvers may not be effective at high rates of shear, the effect of pressure not having been investigated. Industrial and special lubricants and electrical oils were also discussed.

Construction Materials. This section dealt mainly with materials, construction, equipment and corrosion. One interesting proposal made by two French authors is for a method of heat exchange whereby the two fluids are in direct contact. It was stated that it is effective where there is no danger of emulsions being formed due to the nature of the oil or of the cooling water.

Miscellaneous. Sections 9 and 10 dealt respectively with transport, storage and distribution of petroleum products, and with economics, statistics, documentation, education and training.

HUMAN PROBLEMS OF THE SCOTTISH HIGHLANDS

IN an article in a recent issue of the *American Scientist* (39, No. 2; April 1951), Dr. Fraser Darling discusses recent concepts of human ecology. Human ecology, he suggests, deals with the structure of animal communities which man dominates and their development through the ecological principles of succession. With Paul Sears he believes that "the social function of ecology is to provide a scientific basis whereby man may shape the environment and his relations to it as he expresses himself in and through his culture patterns". To-day it would not

be wise to set up human ecology as an exact science but rather to say that human problems may be nearer solution if they are tackled ecologically. Human ecology and social science can be good science but should not be confused with social service, as is so often done.

Dr. Fraser Darling also considers whether there is any difference between human ecology and social anthropology. If there is any difference between them, he suggests, it is that human ecology deals essentially with process, and the value of the ecologist in society will be in his power and accuracy in elucidating causes and forecasting consequences.

The West Highlands of Scotland, for example, may serve to illustrate the ecological approach to the study of behaviour. In the Highlands there is a very old and, in many ways, primitive human culture existing in an administratively awkward and physically refractory terrain set on the fringe of a highly industrialized urban civilization. Highlanders have been part and parcel of the national structure of Britain for only two hundred years, having until then lived a different kind of life in standards, laws, language and techniques from the rest of Britain. Yet Highlanders are not New Hebrideans or Eskimos over whom British people, try as they may to the contrary, feel some kind of mental superiority. The Highlanders are a race of people of probably greater average intelligence and intellect than the rest of the British community though indistinguishable from it in physical appearance. As members of this race moved so smoothly and successfully in the 'dominant' civilization, it was overlooked how different was the inner rhythm of life and the style of thought and tradition. The new centralized British government of that day merely extended its administrative, economic and social regime to include the Highlands, and with some ameliorations and some encrustations this applies to-day.

In human ecology, too, history can never be neglected; a cross-sectional social survey is not ecological unless it studies origins and successions or, in other words, process. The significance of political action as an environmental factor must also be remembered. The manipulation of the salt tax, for example, in the last part of the eighteenth and early nineteenth centuries had profound results on the lives of Highlanders, and the transposition of the English system of poor relief had amazing consequences. Again, the island of Islay was immune from spirit duty in the late eighteenth century, distillers flocked in, the bread corn of the people was deflected to whisky, the distillers were soon making money advances (at their own rates) on the barley crops of small tenants, and drunkenness was rife and the people were reduced to an appalling social state. The detailed research into population movement conducted by the West Highland Survey shows that this island has suffered more than any other part of the Highlands from excessive emigration.

Another historical factor at the root of the Highland problem to-day is the exploitation which natural resources suffered in the past. Among these was the cutting down of forests to supply wood for shipbuilding and iron making. The destruction of the forests meant the removal of cover, and this environmental factor is of great importance in human lives. Lack of cover imposes various social problems in certain kinds of urban communities, and in the Highlands has imposed a set of conventions almost the exact opposite of our own. Darkness is the only cover; but this is supplemented by a build-up of psychological cover. The Tiree crofter visits the Duke of Argyll's factor on the nights of no moon, though he could just as well go in the day. A man and a girl in the Hebrides will ignore each other in daytime should they meet on the road; but he will be calling at her home just about the time of night when in our culture we should have taken our leave. Good manners require that he be gone before it is light.

The ultimate disappearance of the forest was followed by the introduction of sheep farming on the extensive extractive system in the second half of the eighteenth century. The immediate social consequences of this were unfortunate in that the people were pushed to the coast and suffered a forcible social break. In other parts the sheep–cattle ratio is grossly disturbed and conditions for the peasantry become desperate. In the Highlands it is now possible to gauge the social health of the people by knowledge of the sheep–cattle ratio in an area. If the ratio is wide, 30–50 or more sheep to one cattle-beast, there are grave social problems; if it is less than ten, there are few. The sheep–cattle ratio can also be correlated with the age-structure of the population. It is children who keep milk-cows on the land and when the population grows old, as it did in Assynt in 1931, the number of milk-cows goes down.

Nor should the human ecologist forget the diet of the people he is studying. The introduction of the potato in the West Highlands has raised many social problems caused by an increase in the population and a fall in the standard of living.

The attempt to study social and economic problems apart from the ecological background is bound to cause difficulties. Yet, contrary to biological principles, politicians have recently decided to give a substantial subsidy to hill ewes in Scotland. This idea may have worked well in the Southern Uplands of Scotland but in the poor terrain of the Highlands might have been specially designed for further deterioration of the habitat and for fostering social unhealth.

Depopulation and deterioration of the age-structure go together, but they bring a new set of social problems. People in and out of the Highlands have said often that industries should be established there, industries of the kind where wheels go round in an important way. But what has happened? Where such industry has been established, there has been even greater depopulation in the adjacent rural areas; yet the big problem is how to maintain dispersion. Fort William and Kinlockleven may have provided Britain with aluminium; but they have created new social problems and solved none.

In small communities problems of human ecology arising from depopulation and deterioration of the age-structure are manifold. In the first place, the old remain in power and so prevail that they can initiate an era of reaction in the life of a community; so that in a region of strict Presbyterianism, all gaiety for the young is frowned upon and nowhere do the young show greater consideration for the old than in the Highlands. There are many townships where there are but few married couples. Brothers and sisters have cared for their old folk, and now that they are gone they continue living in their parents' houses and cannot bring themselves to the considerable upset of getting married. The social urge and necessary gaiety are not there. This depres-

sion of the vivid social life of man is likely to lead to such undesirable consequences as burning of the hills in an excitement bordering on hysteria.

Religion is also a considerable ecological factor; but it must always be related with other environmental characteristics. In the Highlands a small remote community with poor services might have much more chance of survival if it were Catholic than if it were free Presbyterian; there is a greater sense of freedom in the old liberal and almost Columban style of Catholicism. Dr. Darling also suggests that, despite the fact that tradition and accumulated experience are part of man's environment, and for all the importance of the physical and biological factors, the ethos is still the biggest ecological factor of all in the life of the individual.

MECHANISM OF RESISTANCE TO INSECTICIDE IN HOUSEFLIES

By Dr. J. R. BUSVINE

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LABORATORY tests have revealed interesting differences in the type of tolerance of two strains of insecticide-resistant housefly. The strains investigated were:

Italian Resistant Strain. Following one of the earliest observations[1] of DDT-resistant houseflies, a laboratory colony was started at the Istituto Superiore di Sanita in Rome. A sub-colony was kindly sent to us in 1948 and has been cultured at the London School of Hygiene and Tropical Medicine since, with occasional selection for resistance to DDT[2], but no other insecticide.

Sardinian Resistant Strain. During 1947–50 there was widespread house-spraying with residual insecticides in Sardinia, in connexion with a campaign for the eradication of Anophelines[3]. Flies were observed to have become resistant to 'Chlordane' and gamma benzene hexachloride, as well as to DDT. In October 1950 Mr. J. F. Newman brought to England a colony of these flies and kindly let me have a sub-culture.

Normal (Rome) Flies. A colony started from normally susceptible flies in Rome before wide use of DDT, sent to us in 1948 and maintained here since.

The flies were reared and tested in rooms kept at 27° C. Two methods were used to assess resistance:

(1) *Application Test.* Minute drops (0·4 mm.³) of insecticides dissolved in mineral oil were applied to individual flies, narcotized with carbon dioxide, by an 'Agla' micro-injection apparatus. Median lethal concentrations were estimated graphically from probit/log concentration curves based on 24-hr. kills.

(2) *Knock-down Test.* Observations were made of the rate of knock-down of flies in a 500-ml. beaker treated with acetone solution of DDT to leave a residue of 0·01 mgm. per sq. cm.[4].

Resistance to DDT

Effect of solvent used. Mineral oil was used in application tests rather than acetone (which has been used by other investigators) because of the difficulty of dealing with minute drops of a highly volatile solvent. Some comparative tests with oil and acetone showed how greatly this small point of technique affects the degree of resistance recorded (Table 1).

Table 1

	Median lethal dose (micrograms per fly)		Ratio Sardinian/ normal
	Normal flies	Sardinian flies	
DDT in oil	0·44	7·2	16
DDT in acetone	0·12	36	300

The results obtained with acetone are in line with those of other investigators who have recorded resistance ratios of several hundred to one; but the oil solution results seem more reliable for the following reasons.

The thorax of a treated fly remains covered with a film of oil, forming a primary toxic phase which, by the partition law, saturates all phases (tissues) in the proportion of the original solution. Internal depletion by metabolism could be made good from this reservoir. Losses of the film, by contacts of the fly with the cage, should be equal at all doses, since the volume applied is constant. After application in acetone, the solvent evaporates in a few seconds, leaving supersaturated liquid; this crystallizes out in an hour or so, leaving tiny scales and blobs of DDT crystals at higher doses. As there is no oil film, the cuticle wax of the insect must form the primary phase. There is very little of this, so it is easily saturated, and this saturates other tissues with DDT; therefore, the toxic action on susceptible flies is greater than with oil applications. The resistant flies, however, are able to metabolize the DDT (see below) and deplete the small reservoir in the cuticle wax. The relatively large crystals aggregated on the outside are an inefficient means of maintaining the saturation of the wax, apart from the fact that they may be dislodged by the movements of the fly. This accounts for the higher doses needed to kill the resistant flies.

Speed of 'knock-down' by DDT. In tests in which DDT was applied to the thorax, flies of the Italian and Sardinian strains were about equally resistant to DDT; but in the beaker tests there was a very marked difference, as shown by the results in Table 2.

Table 2

	Normal Rome strain		Italian strain		Sardinian strain	
	Males	Females	Males	Females	Males	Females
Percentage down in 20 min.	86	35	7	0	69	27
Percentage down in 40 min.	100	93	24	11	93	80
Percentage dead after 24 hr.	100	100	19	8	30	11

The Sardinian flies are almost as rapidly paralysed by the DDT as the normal strain, but most of them recover if removed from the surface after 40 min. The Italian flies, as shown by Harrison[2], are highly resistant to the paralysing effect.

Toxicity of DDT after injection. The relative resistance of the three strains of fly to DDT (in oil) was very similar if the insecticide was injected into the thorax instead of being applied to the outside. The median lethal concentrations obtained were about half those in application tests, thus: Rome 0·06 per cent; Italian 1·0 per cent; Sardinian 0·9 per cent. The paralysing effect of DDT was exhibited earlier by the Sardinian flies than the Italian ones, after injection as well as after application of the poison, though the final kills were about the same.

Table 3. Median lethal concentrations of DDT analogues for three strains of housefly compared with rates of dehydrochlorination *in vitro* (according to Cristol, ref. 5)

Compound	Median lethal concentration			Ratio of M.L.C.s III/I	Dehydrochlorination (lit./sec./mol.)
	Rome I	Italian II	Sardinian III		
Bromine-DDT	0·15	2·1	1·9	13	3,470
pp' DDT	0·11	1·7	1·8	16	2,480
DDD	0·22	1·65	1·95	8·4	568
op' DDT	1·3	13·5	4·1	3·2	37
Dimethyl diphenyl trichlor-methane	0·36	7·1	0·75	2·1	11
'Methoxy-chlor'	0·12	1·25	0·27	2·3	10

These observations suggest that the difference in rate of action of DDT on flies of the two strains cannot be explained by differences in rate of penetration of the cuticle.

Resistance to DDT analogues. The relative toxicities of a selection of DDT analogues to the two resistant strains of flies were made by application tests. In Table 3 the results are compared with the ease of dehydrochlorination, *in vitro*, according to Cristol[5]. It will be observed that those compounds which readily split off hydrogen chloride and leave the non-insecticidal ethylenic compound are tolerated by both strains: but the analogues which are more stable in this respect are relatively toxic to the Sardinian strain. Fig. 1 shows that the relative resistance of the Sardinian strain, as compared with the normal (Rome) strain, is roughly proportional to the logarithm of the rate of dehydrochlorination.

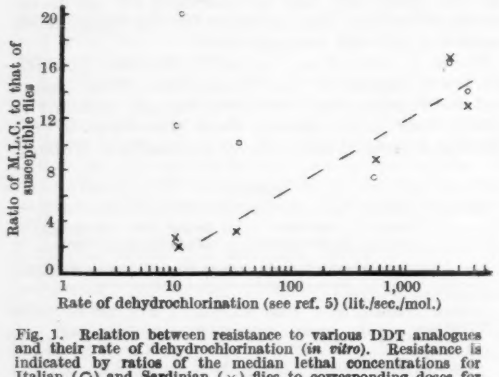

Fig. 1. Relation between resistance to various DDT analogues and their rate of dehydrochlorination (*in vitro*). Resistance is indicated by ratios of the median lethal concentrations for Italian (○) and Sardinian (×) flies to corresponding doses for normal (Rome) flies

Resistance to a Range of Insecticides

The degrees of increased resistance of the two resistant strains, as compared with normally susceptible flies, is shown in Fig. 2 and Table 4 for a range of insecticides. The following points may be noted.

(1) The Italian strain is distinctly resistant to DDT and to pyrethrins, but towards the other insecticides it is as susceptible as the normal (Rome) strain.

The moderate, but quite definite, resistance to pyrethrins is surprising and inexplicable. Houseflies which have so far developed resistance to insecticide in the field have only become tolerant of synthetic, chlorinated hydrocarbon insecticides; that they are capable of becoming resistant to pyrethrins may be of considerable practical importance.

Table 4. Median lethal concentrations of various insecticides, for two insecticide-resistant strains of housefly, compared with a susceptible strain from Rome

Insecticide	Median lethal concentrations			Ratios of M.L.C.'s to Rome strain	
	Rome (Normal)	Italian	Sardinian	Italian	Sardinian
DDT	0·11	1·7	1·8	15·5	16·5
Chlordane	0·04	0·038	2·8	0·95	70
Dieldrin	0·006	0·007	0·3	1·2	50
Aldrin	0·009	0·010	0·3	1·1	33
Gamma BHC	0·006	0·005	0·05	0·85	8·5
Toxaphene	0·09	0·09	0·90	1·0	10
'Lethane'	0·60	0·65	0·70	1·1	1·2
'Thanite'	0·80	0·90	0·85	1·1	1·1
Pyrethrins	0·07	0·35	0·06	5·0	0·86

(2) The Sardinian strain is about as resistant to DDT as the Italian strain. In addition, it is highly resistant to chlordane and several other chlorinated hydrocarbon insecticides. The resistance to chlordane is not surprising, in view of the wide use of this insecticide in Sardinia, but dieldrin and aldrin and toxaphene have not been used there. The two first are allied to chlordane in chemical constitution, but toxaphene is not very similar.

Discussion

It is difficult to imagine any single hypothesis which could explain the curious differences in the resistance of the Italian and Sardinian strains. Previous investigators have shown that resistant houseflies are able to break down DDT to a non-toxic compound by dehydrochlorination[6-8]. The data illustrated by Fig. 1 might suggest that the two strains owe their resistance to dehydrochlorination mechanisms with different specific actions; that of the Italian strain being more efficient in dealing with those DDT analogues most difficult to hydrolyse *in*

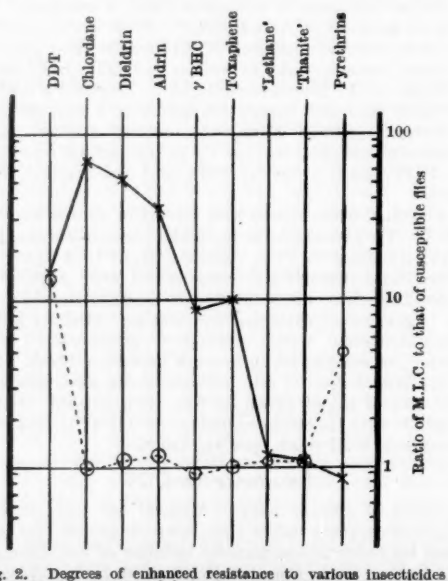

Fig. 2. Degrees of enhanced resistance to various insecticides shown by two strains of housefly. Resistance is indicated by ratios of the median lethal concentrations for Italian (○) and Sardinian (×) flies to corresponding doses for normal (Rome) flies. (Logarithmic scale for convenience)

vitro. However, it is the Sardinian strain which is more efficient in resisting other chlorinated hydrocarbon insecticides, including dieldrin and aldrin, which are difficult to hydrolyse (if we are to judge from results *in vitro*). Furthermore, the resistance of the Italian strain to the early knock-down by DDT cannot be related to a more rapid dehydrochlorination, for Wintringham[8], who worked with this strain, found that it metabolized DDT very slowly (only 23 per cent in 5 hr.).

As earlier writers have suggested, the dehydrochlorination mechanism does not fully account for DDT resistance, and one is driven to postulate an additional defence mechanism. This would partially explain my results, assuming that the unknown mechanism predominates in the Italian strain, while the Sardinian strain relies mainly on dehydrochlorination.

[1] Sacca, *Riv. di Parasitol.*, **8**, 127 (1947).
[2] Harrison, *Bull. Ent. Res.* (in the press).
[3] Busvine, *Discovery* (March 1950).
[4] Busvine, *Ceylon J. Med. Sci.*, (D), **4**, 1 (1949).
[5] Critsol, *J. Amer. Chem. Soc.*, **67**, 1494 (1945).
[6] Sternburg *et al.*, *J. Econ. Entom.*, **43**, 214 (1950).
[7] Perry and Hoskins, *Science*, **111**, 600 (1950).
[8] Wintringham *et al.*, *Nature*, **167**, 106 (1951).

CARNEGIE INSTITUTION OF WASHINGTON

ANNUAL REPORT FOR 1949–50

THE annual report for 1949–50 of the Carnegie Institution of Washington* includes the report of the president of the Institution, Dr. Vannevar Bush, as well as those of the executive committee and the auditors, and also the yearly record of departmental activities and co-operative studies.

The feature of the president's report is the discussion of the nature of research, and especially the methodology of the basic scientific research with which the Institution is primarily concerned. This is defined as the effort to extend, for its own sake, our grasp of the workings of Nature and of man, while applied research seeks to produce a new and useful device, material or process by capitalizing the growing body of fundamental knowledge. In both types of research there are two general approaches. One is to improve the tools, including the use of mathematical analysis, and usually proceeding by refinement, painstaking examination of sources of error and by testing of available materials. In the second a concerted attack is made upon a specific problem, applying all possible methods and instruments, and creating new ones for the purpose. Dr. Bush points out that even the objective centralized attack often turns the investigator into unexpected paths, and it is essential to keep in mind the true relation between the man of science and the instruments he uses. These are aids, not objects, and are important only as they foster the creative activity of the investigating mind. What distinguishes the really great man of science is the ability to sense or discern those places where truly great significance lies and where the tools available can open up a really wide crack in the wall of the unknown. More than forty years of experience has justified Andrew Carnegie's conviction that an institution which sought out the unusual scientific worker and made it possible for him to create to the utmost would be worth while.

Reviewing the research activities of the year, Dr. Bush refers to the publication during the year by Dr. R. E. Wilson and Dr. A. H. Joy of the radial velocities of 2,111 stars, thus essentially completing a programme begun by the Mount Wilson Observatory in 1910 which has yielded velocities of about 14,000 stars of all spectral types. During the year the 200-in. Hale telescope and the 48-in. Schmidt camera took their place with the 100-in. and 60-in. telescopes on Mount Wilson on the regular observing schedules of the Observatories. On June 26, 1949, Dr. W. Baade with the 48-in Schmidt camera discovered the trail of a very unusual asteroid which has now been found to possess the shortest period (409 days) of any known asteroid and comet and has been named Icarus.

At the Geophysical Laboratory of the Institution careful measurements on about three hundred specimens of quartz have shown easily measurable differences in the behaviour of crystals from granite and those believed to have been formed in the later stages of igneous activity. Measurements on the effect of pressure on the inversion-point of quartz indicate that at the maximum pressure reached—corresponding to a depth of twenty-miles below the surface of the earth—the inversion-point is raised by more than 200° C. Further work on the feldspars has yielded quantitative information on their co-existence and stability, and the conditions of temperature and pressure under which they have been formed. Measurements on the melting of silicates in the presence of water under pressure have also continued, and the high-pressure steam filter autoclave has been further developed. Studies, in co-operation with the Department of Terrestrial Magnetism, of the earth's crust using waves produced by large explosions resulted in agreement that the velocity of earthquake waves is 5·9–6·0 km./sec. and also, reducing our estimate of the thickness of the upper layer, bring into agreement the shear-wave arrival times for near earthquakes. The same Department has continued its measurements of the residual-magnetism properties of sedimentary rocks, and studies on the direction of easiest magnetization indicate that these directional magnetic properties had their origin when the rocks were laid down as sediments. A great increase of cosmic rays coincident with a great solar flare was again observed; these high-energy radiations appear to be a nucleonic component of cosmic rays coming to the earth from the vicinity of the sun, and the observed particles are not mesons. The study of proton–proton scattering has continued, and, as a result of biophysical studies using radioactive tracers on the effect of inorganic ions on cellular activity, the ability of organisms to concentrate potassium from their environment can be interpreted in terms of the formation of relatively stable potassium compounds within the cell.

Investigations on photosynthesis, in the Division of Plant Biology, have been concentrated primarily on the photochemical part of the reaction by which the light absorbed by the various chloroplast pigments is converted into chemical energy. It has been found that the fluorescence spectra of red algæ do not match the summations of the fluorescence spectra of their purified pigments, although the different pigments do function to some extent independently. A

* Carnegie Institution of Washington. Year-Book No. 49, July 1, 1949–June 30, 1950, with Administrative Reports through December 15, 1950. Pp. xxxvi+220+7 plates. (Washington, D.C., 1950.) 1 dollar.

highly fluorescent pigment, present in the cells which surround the so-called guard cells controlling the openings through which gases enter the leaves of certain species of vetch, possesses a fluorescence spectra resembling those of certain types of porphyrins. A mutant of *Chlorella* has been found which contains chlorophyll, but is incapable of reducing carbon dioxide, although it can evolve oxygen when illuminated. Chloroplast experiments have shown that the reactivation by precipitation of disintegrated chloroplast material depends primarily upon the physical state of the precipitate, and similar results have been obtained by treatment with various salts, by increased acidity, and by very low concentrations of streptomycin, which combines specifically with the chloroplast material. Methods have been worked out for separating uronides from leaves, and it appears possible that the great variations, independent of photosynthesis or respiration, of sugar concentration in leaves, may be associated with a reversible formation of uronides, which ties up the sugars. The principles controlling the evolution of plants have been studied by examining the growth of contrasting climatic races under varied temperatures in controlled greenhouses at the California Institute of Technology. The *Poa* grasses included with hybrids of *Achillea* and *Mimulus* in these studies were also used in studies of the influence of environment on chromosomal pairing.

In the Department of Embryology of the Carnegie Institution one of the chief advances on the anatomical side has been the achievement of sex reversal of the gonad in the opossum by experimental treatment in the embryonic stage with the female sex-hormone œstrogen. A detailed study of the embryonic development of the external muscles of the human eyeball was being prepared for publication, and studies on the developing brain and liver, with respect to chemical factors in the synthetic activities which characterize fœtal growth, indicate that specific chemical changes can be correlated with changes in the form of the developing nerve cells as seen under the microscope. The investigation on the physiology of the uterus has led to the development of the multi-channel tokodynamometer, by which obstetricians can record the contraction of all parts of the human uterus in childbirth and distinguish normal patterns of contraction from abnormal types which do not permit smooth and properly timed passage of the infant. Studies of the action of drugs upon the uterus were being continued, and an investigation of the biochemistry of uterine muscle in relation to the functional states of the reproductive system has shown that the presence of an effective amount of actomyosin in the uterus depends upon the ovarian sex hormone or œstrogen.

TEA RESEARCH INSTITUTE OF EAST AFRICA

A NEW research institute concerned with problems bearing on the cultivation and manufacture of tea has been inaugurated at Kericho, Kenya Colony, to serve tea producers in the three East African territories. Well-equipped laboratories have been built and a nucleus staff is in residence. At present the activities of the Institute are divided between a general agricultural department, covering agronomic and pathological problems, and a chemical department concerned with soils and plant biochemistry.

The funds for the support of the Institute are provided by the territorial Tea Boards of Kenya, Tanganyika and Uganda, which were recently established by legislative ordinances for the regulation of tea production, marketing and export.

Following the example of the British Grassland Research Station, the Institute has been incorporated as a company limited by guarantee without share capital, in Kenya, thus obviating the necessity for parallel legislative action in three territories of different constitutional status.

The governing body consists of ten members, six of whom (two from each territory) are nominated by the Tea Boards to represent producers, the remaining four being the directors of agriculture in the territories and the director of the East African Agriculture and Forestry Research Organization. The latter, Dr. B. A. Keen, has been elected chairman. During the preliminary stages of establishment, pending the working out of a constitution, the affairs of the Institute were sponsored by Messrs. Brooke Bond and Co., Ltd. On this account buildings and development generally were able to proceed without delay.

The tea industry in East Africa is relatively young and dates back about twenty-five years. The approximate acreage of mature tea in East Africa is 33,000, with a production of 19,000,000 lb. in 1950. East Africa has contracted out of the international agreement for restriction, and production is expanding. The immediate problems for a research institute are therefore largely concerned with soil and fertility conservation, establishment of young tea and the improvement of types of tea by selection.

DEVELOPMENT OF THE MAMMALIAN LYMPHATIC SYSTEM

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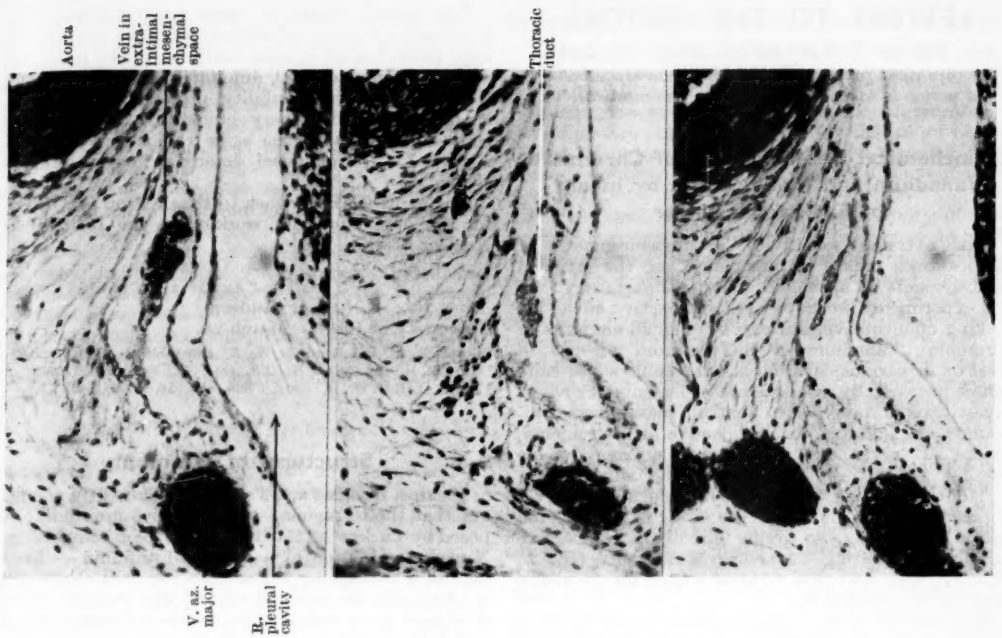
THE problem of the development of the lymphatic system in the mammal still remains unsettled. Sabin[1] regards the lymphatic vessels as direct derivatives of the embryonic veins. The lymphatic vessels make their first appearance at the four centres of radiation in relation to limb girdles. By the process of continuous and uninterrupted sprouting they extend centrifugally and invade almost the entire body. Lewis[2] believes that the lymphatic vessels are formed by the confluence of multiple venous outgrowths. These venous derivatives have previously become detached from the main venous channels and later they transfer *in toto* to the lymphatic system. Huntington[3], Huntington and McClure[4] and Kampmeier[5] have shown that the systemic lymphatic vessels are formed by fusion of the perivenous mesenchymal spaces. These spaces develop as separate lymphatic anlagen outside the intima of the early venous channels. They do not communicate directly with the veins except at definite points in the lymphatico-venous connexions which are secondarily formed. The connecting segments between the veins at the root of the neck and the proper systemic lymphatic vessels are provided by the paired jugular lymph sacs.



Three stages of degeneration in one of the right ventromedial tributaries of the azygos vein engulfed within the developing thoracic duct

The present investigation has been made into the development of the lymphatic system in the sheep and man. The findings confirm in the main the view advocated by Huntington, McClure and Kampmeier. Developmentally, the thoracic duct seems to consist of two separate components. The terminal part is formed by direct venous outgrowths forming the jugular lymph sac. The greater part (systemic lymphatics), on the other hand, arises *in situ* by the confluence of a system of mesenchymal spaces which in the majority of cases develops in close association with the degenerating veins. Therefore, the endothelium lining the greater part of the thoracic duct is derived from the undifferentiated mesenchymal cells, which never served previously as the lining of the venous channels. This is in sharp contrast with the development of the jugular lymph sac. The sac merely serves as a link between the great veins at the root of the neck and the rest of the proper systemic lymphatics; thus only the terminal parts of the thoracic duct and the right lymphatic duct are directly derived from the embryonic veins.

Three different stages can be recognized in the process of the formation of the systemic part of the thoracic duct: hæmal, transitional and lymphatic. The development proceeds in the cranio-caudal direction and different stages may overlap each other. In the hæmal stage venules and venous capillaries (venolymphatics of Kampmeier) are laid down along almost the entire distance eventually occupied by the thoracic duct. These venous capillaries possess two main functions: to drain the blood back towards the heart and to absorb the tissue fluid. During the transitional stage, these small veins become detached from the main venous channel and can no longer fulfil their previous functions. Thus the tissue fluid and the lymph which drains towards them accumulate to form cavities in the mesenchyme outside the lumina of the detached veins. The isolated cavities are known as the extra-intimal or perivenous mesenchymal spaces. They are in actual fact the primordia of the lymphatic channel. In the lymphatic stage the extra-intimal mesenchymal spaces become enlarged and coalesce with each other mainly in the cranio-caudal direction, thus giving rise to the continuity of the main lymphatic channel. The detached veins under the pressure of the expanding mesenchymal spaces degenerate and finally collapse and merge into the surrounding tissue.

In the 29–30 mm. stage human embryo, though the continuity of the thoracic duct from the innominate vein at the root of the neck to the first lumbar vertebra has been established, the detached veins in various stages of degeneration can still be observed, as shown in the accompanying three illustrations.

During the course of investigation, the posterior lymph sacs, the retro-peritoneal lymph sac and the mesenteric lymph sac were not demonstrated satisfactorily as direct derivatives of veins. The existence of these sacs must be regarded as doubtful. As in the case of the greater part of the thoracic duct, the cisterna chyli develops from the confluence of the extra-intimal spaces. However, it differs from the other systemic lymphatics only by the more extensive coalescence of the mesenchymal spaces and their subsequent enlargement. [March 22.

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LETTERS TO THE EDITORS

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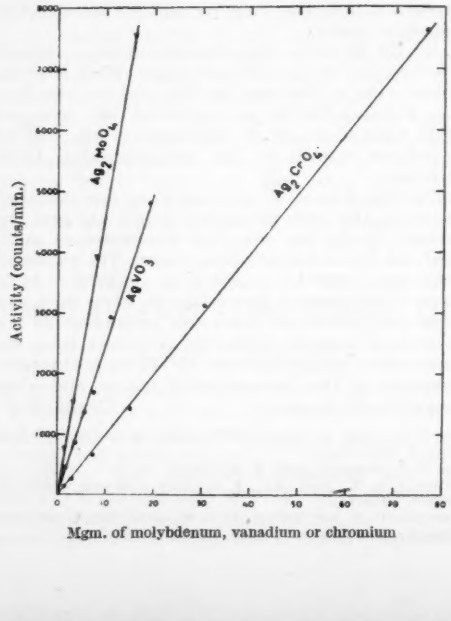
Radiochemical Determination of Chromium, Vanadium and Molybdenum by means of Radioactive Silver

The extreme sensitivity of measurements of radioisotopes makes it possible to use the artificial radioelements as an aid in analytical chemistry. In our experiments we have used radioactive silver for making quantitative estimations of small amounts of chromium, vanadium or molybdenum present in steel or in various substances. Insoluble silver salts can be prepared by means of these elements. Previous investigations have shown that all these silver compounds are suitable for radioactive measurements, except silver vanadate, which gives no reproducible results. Therefore, we dissolve the silver metavanadate in boiling 50 per cent nitric acid, and silver is precipitated as chloride; the latter is filtered on a fritted glass filter, so giving directly a radioactive sample for counting. A Geiger–Müller tube (*R.C.L.* Chicago) with thin mica window is used for the radioactivity measurements.

Radioactive silver, $^{110}_{47}Ag$ (supplied by the Isotope Division, Atomic Energy Research Establishment, Harwell), is dissolved in nitric acid, and the solution is evaporated to dryness on a water-bath. A neutral solution of radioactive silver nitrate is prepared; and by means of this solution chromium is precipitated as silver chromate[1], vanadium as silver vanadate[2] and molybdenum as silver molybdate[3]. As shown in the accompanying graph, standard curves are obtained when the activities of the precipitate are plotted against the corresponding amount of metal used. From these curves, unknown concentrations of chromium, vanadium or molybdenum can easily be determined if the same experimental and geometrical conditions are reproduced.



Less than 1 mgm. of metal can be determined. However, a solution of radioactive silver nitrate with very much higher specific activity can be used, and eventually the smallest amount of metal detectable is limited by the solubility product. This radiochemical method is very quick, accurate and also convenient, because the same radioactive indicator is used for the chemical determination of different elements.

One of us (C. B.) wishes to thank Prof. G. Guében for the opportunity of working in the Institute of Nuclear Studies, Liège.

J. Govaerts
Carlos Barcia-Goyanes

Institute of Nuclear Studies,
University of Liège. March 20.

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Structures of Uranium

Dickins, Douglas and Taylor[1] have recently pointed out that the tetragonal structure for β-uranium, proposed by Tucker[2] on the basis of the room-temperature X-ray examination of a quenched uranium – chromium alloy containing 1·4 atomic per cent chromium, is essentially the same as that of the σ-phase, which is of such great technical importance. Kasper, Decker and Belanger[3] have obtained similar results.

We have been engaged for some time in the X-ray examination of uranium at high temperatures and have succeeded in obtaining satisfactory powder photographs of β- and γ-uranium, using filings sealed off in an evacuated silica capillary tube. Attempts made to index the β-photographs by the method described by Ito[4] had led to a monoclinic unit cell containing 30 atoms and having the dimensions $a = 9{\cdot}99$ A., $b = 7{\cdot}85$ A., $c = 8{\cdot}67$ A. and $\beta = 101° 42'$; but comparison of these photographs with those of a 1·4 atomic per cent chromium – uranium alloy quenched from 720° C. showed that there was a very strong resemblance, although obviously the unit-cell dimensions of the two substances differed considerably.

Detailed analysis showed that all the lines of the β-uranium photograph could be explained with a tetragonal unit cell containing 30 atoms and having the dimensions shown in the accompanying table, with the exception of two very faint lines. Several small-angle reflexions, occurring only as spots on photographs of stationary specimens, were also explained more satisfactorily by the monoclinic than by the tetragonal unit cell; but there was no unequivocal evidence that the tetragonal structure is not essentially correct. However, there are marked discrepancies between the calculated and observed intensities which show, as Tucker himself says, that much more work is necessary before the final structure of the uranium – chromium alloy can be elucidated. More significant, perhaps, are the intensity differences observed between β-uranium and the uranium – chromium alloy, which show that the two structures, although based on the same theme, are not identical, and make it clear that the detailed structure of β-uranium will have to be worked out from X-ray observations on the element itself and not on the chromium alloy. (*Note added in proof.* X-ray photographs of the uranium–chromium alloy taken at 720° C. have confirmed these intensity differences.)

There is one feature of this alloy which may be of interest, although not strictly relevant in the present context; and that is its behaviour on filing. Filings prepared for X-ray examination gave only the α-uranium pattern if examined before re-heating to 720° C. and quenching. After the latter treatment, however, the σ-pattern was re-established.

The accompanying table gives the unit-cell dimensions and theoretical density for β-uranium and the uranium – chromium alloy as well as for the body-centred cubic unit cell of γ-uranium, together with previously reported values; and includes also the corresponding figures for α-uranium based on Jacob and Warren's results[5], taking into account that their dimensions almost certainly refer to kX. and not to angstrom units, and that they used a value of $0{\cdot}606 \times 10^{-24}$ for Avogadro's constant instead of $0{\cdot}6024 \times 10^{-24}$, the currently accepted value.

UNIT-CELL DIMENSIONS AND DENSITY

	α-U (room temp.)	β-U (720° C.)	γ-U (805° C.)	U–Cr (1·4%) (room temp.)
a (in A.)	2·858	10·759 ± 0·001	3·524 ± 0·002	10·590 ± 0·001
b (in A.)	5·877	—	—	—
c (in A.)	4·955	5·656 ± 0·001	—	5·634 ± 0·001
Density	19·00	18·11	18·06	18·56

PREVIOUSLY REPORTED VALUES

a (in A.)	2·852		3·49 (at 800° C.)	10·52
b (in A.)	5·865		—	—
c (in A.)	4·945	None	—	5·57
Density	18·97		18·6	19·02
Ref.	5		6	2

It will be seen that the unit-cell dimensions for the 1·4 atomic per cent chromium alloy are not the same as those reported by Tucker. The precise significance of this is not clear at the moment, but it may be noted that metallographic examination reveals no sign of segregation in the alloy, the composition of which (1·35–1·40 atomic per cent chromium) is not seriously different from that of Tucker's. An estimate of the density of such an alloy, of uncertain value perhaps, may be worked out from measurements of the bulk thermal expansion of uranium[7] in the β-range, extrapolating to room temperature and making an allowance for the effect of the chromium. The value so obtained is 18·8, which is intermediate between Tucker's value and that given by the present work.

It will also be noticed that the figures obtained for γ-uranium differ somewhat from those previously published. Density considerations suggest, however, that they are of the right order, the density at 800° C., calculated from measurements of bulk thermal expansion, being 17·8. A value of 18·6, as given by Wilson and Rundle's results, would therefore seem to be unreasonably high.

This note is published by permission of the Director of the Atomic Energy Research Establishment, and it is hoped to publish fuller details elsewhere. The uranium – chromium alloy was prepared, and the chemical analysis carried out, by the Metallurgy Division of this Establishment.

J. THEWLIS

Atomic Energy Research Establishment,
Harwell. April 30.

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Errors in Determination of Specific Activity and Turnover Rates of Radioactive Isotopes

IN experiments designed to investigate the turnover rate of certain organophosphates by the use of phosphorus-32, a serious error has been detected in the results obtained by the use of conventional techniques.

For the determination of the radioactivity of the inorganic phosphate fraction of a trichloracetic acid extract of tissue, the phosphate is generally precipitated as a magnesium ammonium salt and counted as such. It is also customary to add unlabelled phosphate to serve as carrier and so ensure complete precipitation of the phosphorus-32. In order to avoid the loss of time due to the necessity for allowing the solution from which phosphorus-32 is being precipitated to stand several hours, we investigated the possibility of applying the method for the determination of inorganic phosphate described by Ennor and Stocken[1]. If it was possible to extract the inorganic phosphate from the aqueous phase with *iso*butanol in 10 sec. as has been reported, we believed that the phosphorus-32 content could be determined by counting the alcohol phase in a conventional liquid counter of 10 ml. volume. Preliminary experiments using a model system containing sodium dihydrogen phosphate, some of which was labelled, have indicated that not only can the phosphorus-32 be extracted quantitatively in 10 sec., but also that the counts obtained by this method agree with those obtained by counting the precipitate of magnesium ammonium phosphate.

When, however, a similar comparison is carried out on a trichloracetic acid extract of a liver from an animal injected with material labelled with phosphorus-32 two hours before death, divergent results are obtained.

From the results of the model experiment, it was expected that the counts in the magnesium precipitate would equal those in the *iso*butanol extraction of the trichloracetic acid extract. It is clear, however (see table), that the precipitate has many more counts. In both the examples cited, an extraction of the precipitate with *iso*butanol gives results practically identical with the extraction of the trichloracetic acid extract. This result is taken to indicate the presence of a compound containing phosphorus-32 which does not react with molybdate to form a phosphomolybdate complex, and so remains insoluble in *iso*butanol. This conclusion is strengthened by the fact that after wet-ashing in sulphuric and nitric acids, butanol

Magnesium precipitates were counted by means of a *GM4* end-window counter and were mounted on disks of filter paper. All *iso*butanol extracts were counted in an *M6 GM* liquid counter having a capacity of 10 ml. All determinations were carried out in duplicate and counts were taken over such a period as to reduce the statistical error to 1–2 per cent. All counts are expressed in terms of the end-window counter

	Counts/min./ml. of extract Exp. 1	Exp. 2
Magnesium ppt.	850	1,540
*iso*Butanol extraction of ppt.	560	1,240
" " " trichloracetic acid extract	540	1,280
" " " ashed ppt.	900	1,540
Specific activity (based on ppt.)	8·1	10·0
" " (based on *iso*but. extraction of trichloracetic acid extract)	5·3	8·1

extraction now gives the same number of counts as did the precipitate.

The error which appears as a result of differences between the counts in the *iso*butanol and in the precipitate is reflected in the specific activities, as indicated in the accompanying table.

The question now arises as to the nature of the contaminant, and preliminary experiments indicate that the adenosine polyphosphates are co-precipitated as, in fact, has been noted by Lehninger[2]. It has also been established that the degree of co-precipitation is dependent upon the amount of carrier phosphorus which has been added.

The preliminary results indicate that the long-accepted method for determination of the radioactivity of inorganic phosphate is subject to considerable error and, therefore, that the conclusions that have been drawn in the past on the turnover rate, etc., of an organophosphate are also subject to error. Experiments are now in progress to determine the magnitude of this error. It has also been established that the method described by Ennor and Stocken[1] is suitable for the determination of both phosphorus-31 and -32, and that it is free from error. A full report of the work will be submitted for publication elsewhere.

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May 18.

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A Particulate Impurity Found in Solutions of Radioactive Phosphorus

Experiments involving the use of radioactive phosphorus (phosphorus-32) incorporated into nucleoproteins have indicated that samples of nominally carrier-free radioactive orthophosphate contained, at various times during 1950, an appreciable proportion of activity associated with particulate matter. Recent samples of phosphorus-32 have, however, been free from this impurity. This impurity is of serious consequence when measurements of the radioactivity of proteins labelled with phosphorus-32 are to be made, as the impurity is carried down on protein precipitates, where it remains in spite of repeated washing.

The nature of this impurity has been investigated and a method for removing it from solutions of radioactive phosphorus has been devised. The uptake of the impurity by protein (crystalline horse serum albumin) precipitated from a carrier-containing solution by trichloracetic acid was unaffected by the amount of protein used or the amount of carrier present over a wide range. The protein precipitate (see table) was separated by centrifugation from the supernatant fluid, which was then neutralized, more protein was added and the precipitation repeated. The second precipitate was found to contain less than one-thousandth of the radioactivity found in the first, whereas both precipitates contained essentially the same amount of phosphorus. The degree of contamination of the first precipitate by carrier-free phosphorus-32 is indicated by the ratio of its specific activity to that of the supernatant fluid (final column of table), which in the absence of impurity cannot be greater than 1. This experiment has been repeated using a tissue homogenate instead of horse serum albumin, with similar results. A high activity persisted in the first precipitate after ten washings in phosphate-containing trichloracetic acid, whereas the second precipitate gave only background counts after six washings.

The impurity extracted has the same decay-rate as phosphorus-32 and was thought to be radioactive orthophosphate adsorbed on to, or combined with, some extraneous particulate matter suspended in the carrier-free solution. An attempt was made to remove the impurity by filtration of carrier-containing material through a 0·25-μ 'Gradocol' membrane. This proved as effective as protein precipitation in removing the impurity, only background counts being obtained on a washed precipitate from filtered material, an aliquot of which before filtration had given a highly active washed precipitate. The impurity may also be removed by extracting the orthophosphate in *iso*butyl alcohol as a phosphomolybdate complex, when the impurity remains in the aqueous phase; after alkaline hydrolysis the impurity behaves like orthophosphate and is found in the alcoholic phase.

In experiments involving nucleoproteins in which nucleic acid turnover is measured by means of phosphorus-32, Schmidt and Thannhauser's method of fractionating the nucleic acids is frequently used. In this fractionation the radioactivity due to the impurity is removed from the protein during alkaline hydrolysis and appears as radioactive orthophosphate in the ribose nucleotides fraction, where it will give rise to gross errors. If reliable results are to be obtained from experiments involving proteins labelled with phosphorus-32, it is essential to ensure that the tracer solution is free from this impurity. Filtration through a 0·25-μ 'Gradocol' membrane after addition of carrier provides a reliable and simple method of doing this, while at the same time sterilizing the solution.

	Total counts per min.	Percentage activity in precipitate	Phosphorus (μgm.)	Specific activity (counts per min. per μgm. phosphorus)	Ratio of spec. activities of precipitate to supernatant
Supernatant 1	195,000	—	858	228	—
Supernatant 2	198,000	—	900	222	—
Precipitate 1	10,800	5·5	3·9	2,700	11·8
Precipitate 2	7·8	0·004	4·5	1·74	0·008

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Inert Gas Effects in the Oxidation of Hexane

According to one scheme of hydrocarbon oxidation[1], a link in the gaseous reaction chain at low temperatures is the formation of a peroxide radical:

$$R + O_2 \rightarrow RO_2^*, \qquad (1)$$

followed by:

$$RO_2^* + RH \rightarrow ROOH + R. \qquad (2)$$

(The formation of RO_2 appears to have been first proposed for the low-temperature oxidation of gaseous higher alkanes by A. R. Ubbelohde[1]. Other authors have proposed variants which still involve (1) as a step in the oxidation mechanisms.) Until it can be dissipated, for example, by collisions with other molecules, the energy of reaction must be stored for a short time in the RO_2^* radical. Various physical properties[2] of the hydrocarbon molecule may facilitate this storage of internal energy in reaction intermediates for much longer periods than would be possible in the combination of simpler groups, as in

$$H + O_2 \rightarrow HO_2. \qquad (3)$$

The energy stored can be utilized in a subsequent process in the reaction chain, such as reaction (2), provided that this reaction can occur before collisions in the gas phase favour the competing deactivation reaction:

$$RO_2^* + X \rightarrow RO_2 + X^*, \qquad (4)$$

where X is any third body. A possibility of this kind has been put forward (ref. 1, p. 373) as one of the factors which explain the much greater influence on reaction velocity of increasing the concentration of hydrocarbon rather than the concentration of oxygen.

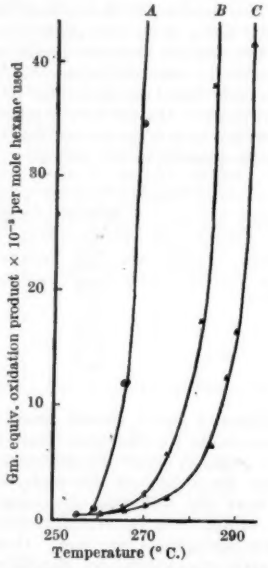

Fig. 1. Effect of diluents on hexane oxidations

	C_6H_{14}	O_2	N_2	Diluent	
Reference mixture	2·87	1	4	—	
With added nitrogen	2·87	1	4	4·26	N_2
With added hydrogen	2·87	1	4	4·26	H_2

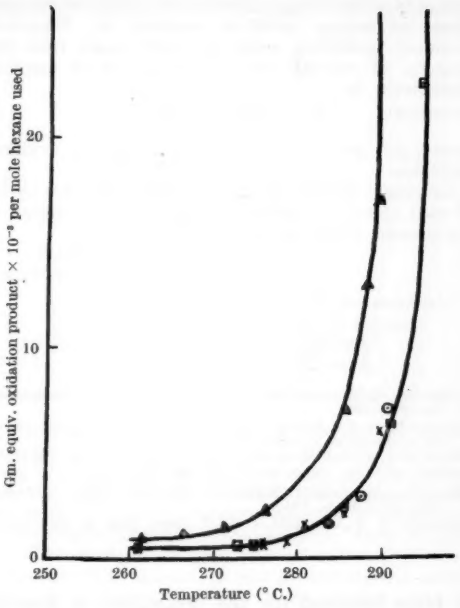

Fig. 2. Inhibition by mercury.
Mercury trough at 50° C., □; at 30° C., ×; at 0° C., ⊙

In the oxidation of gaseous acetaldehyde, it has recently been found[3] that dilution of the system by hydrogen leads to much more marked inhibition than dilution by nitrogen when introduced in comparable molecular proportions. Specific inhibition by hydrogen has now also been found for hexane oxidations using a flow system closely resembling that previously described[3]. In Fig. 1 the reaction temperature is plotted against the extent of oxidation, as measured by the total sum of peroxide, aldehyde and acid analysed in the condensible reaction products.

It seems likely that this specific inhibitory effect of hydrogen arises from energy-transfer processes in which collision with hydrogen is much more efficient in a reaction such as (4) than collision with nitrogen. The principle of microscopic reversibility indicates that if hydrogen is specially efficient in *removing* internal energy by collisions such as (4), it should also be much more efficient than nitrogen in other circumstances where the *supply* of internal energy by collisions involves the reverse of reaction (4). An elegant verification of the special efficiency of collisions with hydrogen for the transfer of internal energy is found in its influence on the thermal decomposition of ethers[5]. Similar evidence is obtained from ultrasonic measurements on vibrational specific heats[6].

We have also found that traces of mercury vapour slow down oxidation both in hexane + oxygen + nitrogen and in hexane + oxygen + (nitrogen + hydrogen) mixtures. For this purpose mercury was held (at the point A, see Fig. 1 in ref. 3) in a small trough heated electrically so that mercury could be vaporized into the gas stream at the desired temperature. For simplicity, only the inhibition observed in the presence of hydrogen as increased by the presence of mercury vapour is shown in Fig. 2. Since this added inhibition is not sensitive to the concentra-

tion of mercury, it may involve the action of mercury atoms as energy sinks in reaction (4). However, chemical inhibition such as could result from the removal of radicals by the formation of mercury derivatives in

$$R\cdot + Hg \rightarrow RHg\cdot \qquad (5)$$

cannot yet be excluded on the basis of the evidence available.

An effect of hydrogen in suppressing the formation of cool flames in pentane[4] appears to be related to the present observations.

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April 26.

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A New Method for the Detection of Amino-Acids, Peptides, Proteins and Other Buffering Substances on Paper

During the past few years, a large number of papers have appeared dealing with the quantitative determination of amino-acids in paper chromatograms *in situ* or after elution; but no simple satisfactory general method has yet been developed. Chemical reactions of the amino-acids on paper cannot easily be controlled, and results obtained from such reactions must be considered semi-quantitative. Elution of amino-acids after location of the spots in ultra-violet light seems to be the most promising method for quantitative estimation hitherto described. This method is based on the interaction between cellulose and amino-acids, which produces fluorescent substances[1]. The amino-acids take part only in the formation of intermediate compounds, from which they can be recovered quantitatively or almost quantitatively. The reactions are complicated and not fully understood[2].

Our method depends on a different principle. If a paper to which several spots of an amino-acid have been applied is sprayed with dilute acid, hydrolysis of the cellulose occurs only in the regions not occupied by the spots, for the amino-acid buffers the latter regions to a *p*H at which hydrolysis does not occur to a measurable extent. The only remaining requirement is a method of developing the part of the paper which has been hydrolysed. This has been accomplished as follows. The paper previously sprayed with acid is heated to 110–120° C. and then treated with glucose reagents. Orcinol gave the strongest contrast. By replacing hydrochloric acid by sulphuric acid we obtained still better results, depending on more complete hydrolysis and probably on the easier formation of ω-hydroxymethylfurfural from glucose. By the action of sulphuric acid, ω-hydroxymethylfurfural can, however, be converted to lævulinic and formic acids. To avoid this further destruction the orcinol was dissolved in the sulphuric acid solution. In this final method amino-acids applied to the paper as spots could be detected in amounts as small as 0·1 γ.

The most satisfactory treatment seems to be the following. The chromatogram is dried and then uniformly sprayed with a solution of 0·1 per cent orcinol in 96 per cent ethanol made 0·004 *N* in sulphuric acid. (The paper will possibly contain a considerable excess of acid with respect to the buffer substances, but the acid concentration can be varied within wide limits.) The paper is dried at 110–120° C., and after about half an hour the colour is developed. The spots appear white against a red-violet background. In ultra-violet light the spots were easily detectable.

Twenty acidic, neutral and basic amino-acids, some peptides and proteins have been investigated, and all gave easily detectable spots. Fig. 1 shows leucine in different concentrations. Fig. 2 shows a chromatogram developed with butanol–acetic acid.

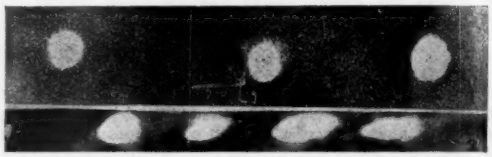

Fig. 1. Spots from left to right contain 5, 10 and 15 γ leucine respectively

Fig. 2. Spots from left to right contain 5 γ glycine, 10 γ alanine, 15 γ tryptophane and 15 γ *iso*leucine

It should be noted also that minute amounts of citrate and borate buffers also gave well-defined spots.

By eluting leucine, lysine and glutamic acid from paper and determining the amino-acids quantitatively according to the method of Moore and Stein[3], it was found that the acids were not destroyed by orcinol treatment. The results of these preliminary experiments are given in the accompanying table. The figures in the right-hand column refer to the orcinol-treated paper, those in the left to the untreated paper. The deviations are to a large extent due to variations in the ammonia content in the paper.

	Calc. (γ)	Found (γ)
Leucine	5·0	5·7
	10·0	9·5
	15·0	15·1
	20·0	19·9
Glutamic acid	10·0	9·0
	15·0	14·5
	20·0	21·2
Lycine	10·0	11·3
	20·0	19·7
	25·0	23·5

The experiments have shown that the method described is suitable for the quantitative determination of amino-acids on paper chromatograms. Because of the greater specificity of the ninhydrin reaction, we suggest that the following procedure should be adopted for amino-acid determinations. Two simultaneous chromatograms are run. One of them is developed with ninhydrin to simplify the exact localization of the amino-acids. After removal of the solvent, the other paper is developed with the orcinol reagent. The two chromatograms are then compared and the spots on the orcinol-treated paper corresponding to amino-acids are cut out, eluted and determined quantitatively according to some suitable method.

Peptides and proteins can be detected in minute amounts, although some hydrolysis may occur in the spots, which perhaps limits the method for preparative purposes.

The method should be of a great value also for the detection of other buffering substances which cannot be identified by more specific reactions. A possible generalization of our method would be to treat the paper with a substance the reaction of which is inhibited by the presence of spots of the compounds under examination.

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Separation of Alkaloids by Paper Chromatography

References to the separation of alkaloids on columns by partition chromatography have been made by Catch *et al.*[1] and Partridge[2]. The theory and use of buffered columns have been previously described[3–5]. In the separation of the penicillins, buffered filter paper has been used[6], and the difficulty of obtaining absolute R_F values for such separations has been noted[7]. The water-insoluble alkaloids of ergot have been separated on unbuffered paper[8].

We have successfully used buffered filter paper for the separation of the strongly basic solanaceous alkaloids, and the feebly basic water-insoluble alkaloids of ergot.

In the case of solanaceous alkaloids, separation of atropine and hyoscine occur, and buffers of *p*H 5–9 were used. A weak solution of iodine in potassium iodide and water was used to detect the alkaloid on the paper. *M*/15 buffer was found to be the most suitable strength, and of the buffers tried phosphate and citrate-phosphate gave the best results, while of the various solvents used *n*-butanol gave the nicest separations. The graphical representation of separations obtained at various *p*H values of a mixture of apoatropine, methyl nitroatropine, atropine and hyoscine is shown in Fig. 1. Similar separations can be made of brucine and strychnine; morphine, narcotine, cocaine and the quinine alkaloids give spots of varying R_F, using butanol and buffered paper.

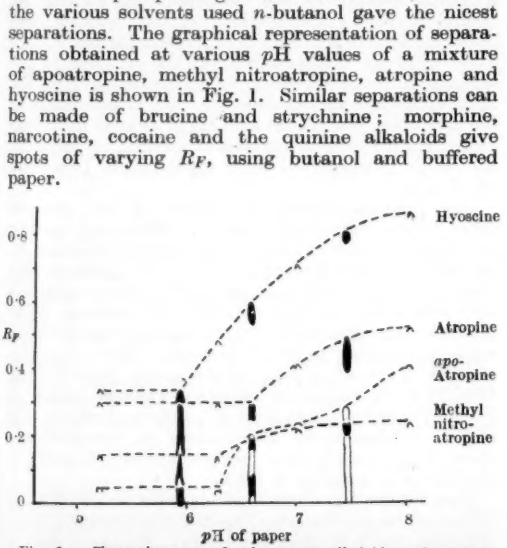

Fig. 1. Chromatograms of solanaceous alkaloids and related products

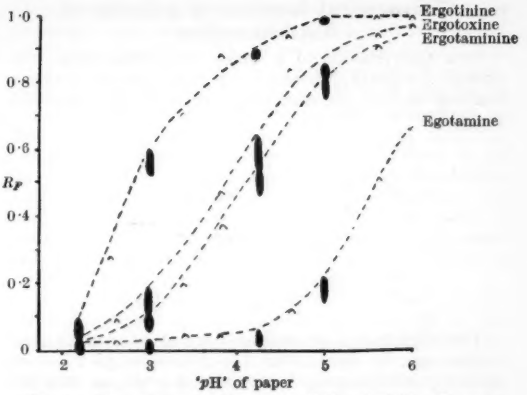

Fig. 2. Chromatograms of water-insoluble alkaloids of ergot

A similar method has been applied to the water-insoluble alkaloids of ergot, with the view of separating the physiologically inactive from the active alkaloids. By the use of buffered filter papers over the range '*p*H 2·2–6', varying degrees of separation of the water-insoluble alkaloids have been carried out. The most satisfactory solvent was diethyl ether saturated with water. In the accompanying graph (Fig. 2) the effect of the '*p*H' of the paper on the R_F value is shown, and the scope of the separations is obvious. With ether as solvent both lysergic and *iso*lysergic acid remain stationary. Ultra-violet light was used to detect the alkaloidal spots.

Quantitative estimations by elution of the alkaloid have not been satisfactory, recoveries varying from 75 to 88 per cent using 15–40 μgm. ergotoxine. These losses are being investigated. No resolution of ergotoxine into ergocristine, ergocornine or ergokryptine was observed in the systems used. Filter-paper chromatography is well suited to the qualitative analysis of the ergot alkaloids in view of the micro amounts used, but for quantitative work more promise is being shown by the use of buffered columns.

It is apparent that by the use of variations in *p*H and different solvents, very complex mixtures of alkaloids should be separable (provided that partition coefficients and/or the *p*K's differ). Thus, valuable information may be obtained for the 'scaling up' of comparable systems for macro separations, the very small amounts of material used in such preliminary investigation being a very desirable feature.

This work will be published in detail and an investigation is proceeding of the quantitative aspects of the separations described.

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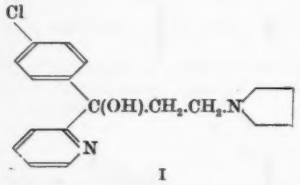
Geometrical Isomers in a Series of Antihistamines

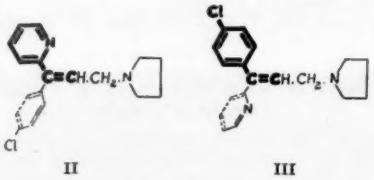
The dehydration of a series of 3-tertiaryamino-1-phenyl-1-α-pyridylpropan-1-ols (for example, I) by heating with 85 per cent sulphuric acid was described recently[1].



I

The allylamines so produced are of interest as antihistamines, in particular 1-*p*-chlorophenyl-1-α-pyridyl-3-pyrrolidinoprop-1-ene, also known as 405*C*49, which is among the most potent of known antihistamines. Further study of the preparation of this compound has revealed the presence of an isomeric base (496*C*50) in the product of dehydration. The isomers were separated by fractional crystallization of their oxalates (405*C*49 base, m.p. 61–62°; oxalate, m.p. 184° (decomp.); 496*C*50 base, oil; oxalate, m.p. 156–157° (decomp.)). The bases are apparently geometrical isomers, for each gave a high yield of the same ketone (*p*-chlorophenyl α-pyridyl ketone, m.p. 63°) on oxidation with chromic acid, and the same propylamine (n_D^{19}, 1·570; oxalate, m.p. 147°), when catalytically hydrogenated.

The ultra-violet absorption spectra of the isomers are remarkably distinctive, the one shown by 405*C*49 being almost identical with that of α-pyridylethylene, while that of 496*C*50 closely resembles that of *p*-chlorophenylethylene (see graph). We interpret these spectra as indicating that in 405*C*49, as in α-pyridylethylene, the α-pyridyl and ethylenic groups are approximately co-planar, on the generally accepted assumption that this configuration is required for maximal electronic interaction of the two groups to which the characteristic light absorption is related. By the same reasoning, the *p*-chlorophenyl group of 496*C*50, rather than the α-pyridyl group, is in the same plane as the ethylenic group. These configurations are represented in formulæ II (405*C*49) and III (496*C*50), in which the approximately co-planar groups are heavily outlined. Chemical and physical evidence is being sought to determine the relative configuration (*cis*- or *trans*-) of the aminomethylene moiety: it was not possible to make a decision on this point from examination of available molecular models.



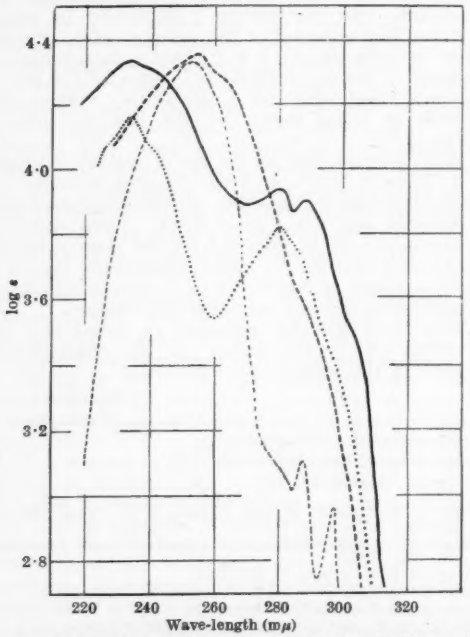
II III

Further, outstanding differences in chemical behaviour of the isomers have been observed. For example, 405*C*49 can be distilled unchanged under reduced pressure, whereas 496*C*50 suffers decomposition; 405*C*49 is unaffected by boiling acetic anhydride, whereas 496*C*50 is degraded to a mixture of products of as yet undetermined constitution. We suggest that these differences in chemical reactivity may be attributed to the different resonance systems preponderating in the isomers.

The dehydration of many related α-pyridyl carbinols has been re-investigated. In each case the results were similar to the example quoted above: two isomers were formed, one being chemically stable and exhibiting the α-pyridylethylene type of spectrum, the other being relatively unstable and having a spectrum similar to the corresponding substituted phenylethylene. Separation of the isomers was usually effected by fractional crystallization of the oxalates or by chromatography, the progress of the separation being followed by measurements of the ultra-violet absorption spectra. The degradation of the unstable (phenylethylene type) isomer by acetic anhydride provided a convenient method for isolating the stable (α-pyridylethylene type) isomer free from the former.

The pharmacological properties of the isomers differ in an interesting manner. High and specific antihistamine activity was shown only by the isomers having the α-pyridylethylene type of structure, the other isomer of each pair invariably being considerably less active in this respect. In contrast, other pharmacological activities were approximately of the same low order in both isomers. For example, 405*C*49 is about eighty times more potent than 496*C*50 when tested on histamine-induced spasm of guinea pig ileum; but the two compounds show only minor differences in antagonism of acetylcholine spasm in guinea pig ileum, corneal anæsthetic activity in rabbits or toxicity in mice.

This series of isomers thus provides an illustration of the selective influence of spatial configuration upon chemical and biological reactivity. We are following up the more fundamental implications of these pre-



Ultra-violet light absorption spectra. Ordinate, logarithm of molecular extinction coefficient; abscissa, wave-length in mμ. ——, 405*C*49; ····, α-pyridylethylene; – – –, 496*C*50; – · –, *p*-chlorophenylethylene

liminary results and intend to examine the application of these concepts to related compounds.

A more detailed description of the present work will be published elsewhere.

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Oxygen Uptake of Nucleated and Non-nucleated Halves of *Amœba proteus*

The removal of the nucleus causes a slow decrease of the ribonucleic acid content of the cytoplasm of *Amœba proteus*[1]. This indicates that the ribonucleoprotein particles (microsomes) subsist in the cytoplasm only in the presence of the nucleus. However, this nuclear control is not immediate, for the ribonucleic acid content of non-nucleated fragments drops significantly only after the fourth day following enucleation.

It appeared of interest to find out whether the oxygen uptake is under nuclear control; a rapid decrease of respiration after enucleation, as stated by Clark[2], might mean that respiratory enzymes, known to be predominantly bound to mitochondria, are dependent on the nucleus for the maintenance of their activity.

Measurements were made on nucleated and non-nucleated fragments of *Amœba proteus*, cut into two approximately equal parts with the aid of a glass needle, and kept fasting; a cylindrical Cartesian diver (gas volume approximately 7 c.mm.) was used. Preliminary experiments indicated that oxygen uptake is proportional to the number of amœbæ when 10–30 amœbæ per diver are studied. We found an average value of $0{\cdot}3 \times 10^{-3}$ c.mm./hr./whole amœba; this figure is almost one-fifth of that given by Clark[2] ($1{\cdot}4 \times 10^{-3}$ c.mm.).

Sixty-nine measurements were performed, using 50–100 nucleated and non-nucleated halves; the time interval after enucleation varied from 1 to 10 days and respiration was studied during 4–5 hr. Duplicate experiments gave consistent results within ± 10 per cent.

As Holter and Zeuthen[3] have shown for intact amœbæ (*Chaos chaos*), the oxygen uptake decreases progressively during fasting and a similar phenomenon was found in the present experiments. But, as is shown in Table 1, the ratio between oxygen uptake of nucleated and non-nucleated fragments remains constant for at least nine days, and the uptake of the enucleated fragments 35–45 per cent that of the total.

In order to check if the oxygen uptake is proportional to the protein content of the two fragments, we determined their tyrosine content according to the principle adopted by Andresen and Holter[4]; we followed detailed instructions kindly sent to us by Dr. Holter. The equal intensity of the Millon reaction in both types of fragments[1] justifies the choice of this amino-acid. As is shown in Table 2, results of these determinations expressed as the ratio between both fragments are reasonably of the same order as those found for oxygen uptake.

It can thus be concluded from the results that: (1) the oxygen uptake due to the nucleus of the amœba must be proportionally small; (2) the absence of nucleus does not prevent the prolonged maintenance of a normal level of oxidation. It then seems probable that the respiratory enzymes bound to mitochondria are largely independent of the nucleus for the maintenance of their activity.

It has recently been shown by Mazia and Hirshfield[5] that phosphorus-32 uptake by amœbæ is strongly dependent on the presence of the nucleus: after twenty-four hours, enucleation results in the ratios nucleated : enucleated varying from 3·1 to 6·5.

Table 1

Day after sectioning	1	2	4	5	6	7	8	9	10
Ratio between respiration of nucleated and of non-nucleated fragments (N/E)	1·36 1·26	1·49 1·49	1·48 1·63	1·26 -	1·47	1·42	1·35 1·22	1·32	1·86 1·71
Oxygen uptake of enucleated fragments as per cent of total	41 44	40 40	43 38	44	40	41	42·5 45	45	35 40

One is therefore led to believe that enucleation leads to a break in the normal coupling between oxidations and phosphorylations: the non-nucleated amœba would thus behave like cells treated with dinitrophenol, which interrupts synthesis by blocking the coupling between oxidation and phosphorylation. Work is now in progress to find out if the nucleus, and in particular the nucleolus, takes any part in the synthesis of the coenzymes necessary for this coupling. Our results, added to those of Mazia and Hirshfield, give us a better understanding of the 'control' of syntheses by the nucleus.

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Table 2

Day after sectioning	1	2	3	8	10
Ratio between tyrosine content of nucleated halves and of non-nucleated halves (N/E)	1·12 1·22	1·29 1·50	1·42	1·78 1·44	1·84

Ergothioneine in the Seminal Vesicle Secretion

Protein-free extracts from the secretory fluid of the seminal vesicles exhibit a marked reducing property towards potassium permanganate and Folin's phosphotungstic reagent in the cold, and towards 2,6-dichlorophenol-indophenol in acid solution. Boar vesicular secretion, which is available in large quantities, was chosen as a convenient source for the isolation of the reducing material. In the course of purification, it was found that the reducing power went parallel with two other chemical properties of the boar vesicular secretion, namely, a strongly

positive diazo reaction and the occurrence of organically bound sulphur which could be oxidized by bromine to inorganic sulphate. This suggested to us that the reducing substance may be the imidazole base ergothioneine (the betaine of thiolhistidine), first discovered by Tanret[1] in ergot, and later shown to occur in low concentrations in red blood corpuscles[2–4]. The application of certain analytical procedures for the determination of ergothioneine[5–7], both in the vesicular secretion and blood of boars, showed that the level of ergothioneine in the vesicular secretion averages 40 mgm. per cent as against 6 mgm. per cent in the blood.

The vesicular secretion collected from the seminal vesicles of four boars (1,300 ml.) was diluted with an equal volume of water and centrifuged; the supernatant was deproteinized with zinc hydroxide[8], the extract concentrated to 400 ml., precipitated with an equal volume of ethanol, the alcoholic filtrate concentrated to 200 ml., treated with 10 ml. 10 *N*-sulphuric acid, filtered again, and the water-clear and colourless solution precipitated with a 50 per cent solution of phosphotungstic acid. The precipitate was decomposed with barium hydroxide, and the solution, after removal of barium, was concentrated *in vacuo* to a syrupy consistency. On gradual addition of ethanol and cooling, crystallization set in, and after two days at 5° C., 480 mgm. of crystalline material was obtained. This gave two further reactions characteristic for ergothioneine, namely, a crystalline derivative with mercuric chloride, and trimethylamine on treatment with alkali. After two recrystallizations from 66 per cent ethanol and drying at 105° C., the substance was analysed—found: C, 47·14; H, 6·57; N, 18·24; S, 14·02. $C_9H_{15}N_3O_2S$ requires: C, 47·14; H, 6·59; N, 18·33; S, 13·98 per cent.

The correlation between the reducing power and ergothioneine content in the seminal fluid of other animals is being examined; but preliminary experiments indicate considerable variations in this respect between species.

This investigation was carried out on behalf of the Agricultural Research Council; one of us (E. L.) is indebted to the British Council for a scholarship, and to Prof. D. Keilin for hospitality in this Institute.

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Inactivation of Adrenotropic Hormone (ACTH) by Plasma

The rapid disappearance from the blood of administered adrenotropic hormone (ACTH) has been demonstrated by Sayers *et al.*[1] using an infusion technique on human subjects, and Greenspan *et al.*[2], after intravenous injection into rats.

In view of the importance of these findings, we would like to report that we have observed the rapid inactivation of an adrenotropic hormone preparation during incubation with heparinized plasma from rats, rabbits and humans. Parallel incubation of the same preparation with the solvent containing an equivalent amount of heparin showed no measurable inactivation when assayed by the Sayers adrenal ascorbic acid depletion assay[3].

The Effect of Incubation at 37° C. for 5 min. on an ACTH Preparation with 80 per cent Plasma from Various Sources

Percentage of inactivation		
Rat	Rabbit	Human
74·9	93·5	90·6

These results will have to be borne in mind when attempting to assay the adrenotropic hormone content of blood of these species.

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Sensitivity to Tuberculin

While a reasonable account can now be given of most stages of the mechanism of the urticarial type of skin response to injected antigens, the observed facts concerning the tuberculin or delayed type of reaction cannot yet be adequately explained. One of the main difficulties has been the failure to demonstrate circulating antibodies by the classical Prausnitz–Kuestner technique. However, Chase[1] showed that sensitivity to tuberculin could be passively transferred by the intra-peritoneal or intravenous injection of white cell concentrates from sensitized animals. More recently, this finding has been confirmed by Lawrence[2], who achieved passive transfer in the human by the intradermal injection of white cells from sensitized donors.

On the basis of tissue culture experiments certain workers, notably Rich and Lewis[3], Moen and Swift[4], had previously suggested a theory of 'tissue' or 'cellular' sensitivity to tuberculin, having demonstrated *in vitro* a cytotoxic action of tuberculin upon tissues from animals with experimentally induced tuberculosis. They found unequivocal evidence of the toxic action of tuberculin upon 'sensitized' wandering cells and observed that, while fibroblasts grew out in culture, their growth-rate was reduced and their cytological appearances altered. Aronson[5] and Raffel[6] demonstrated that bone marrow explants from sensitized animals were killed by tuberculin *in vitro*. No susceptibility of cellular elements to the antigen has been demonstrated *in vitro* when the urticarial or Arthus type of sensitivity has been investigated by tissue culture methods.

The development of a technique for growing explants of adult skin in a fluid medium by Medawar[7] has provided an opportunity for observing the effect of tuberculin upon skin *in vitro*. This technique permits a closer analogy to be drawn between the events following intradermal injection of tuberculin *in vivo*

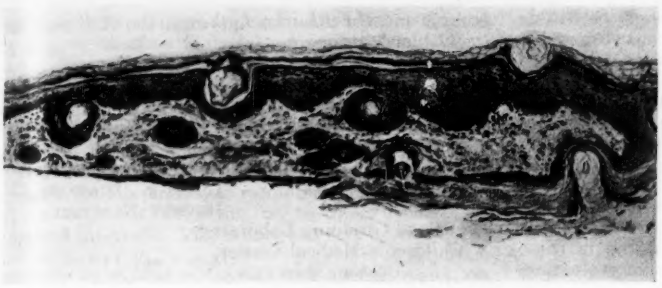

Fig. 1. A 2-day culture of guinea pig skin grown in medium containing purified protein derivative, 0·2 mgm./ml. Hæmatoxylin and eosin (× 100)

Fig. 2. A 2-day culture of skin from tuberculin-sensitive guinea pig grown in medium containing purified protein derivative, 0·2 mgm./ml. Hæmatoxylin and eosin (× 100)

and the submission of skin to various concentrations of tuberculin *in vitro* than the classical culture techniques using plasma jelly. The cells retain their normal growth pattern; epithelium from the epidermis migrates from the cut edges of the explant along the under surface of the dermis and is joined by epithelium spreading from the hair follicles. The dermis does not undergo any obvious change, but appears to retain its normal anatomical and cellular structure (Fig. 1).

In the experiments to be described a modification of the technique (suggested by Prof. Medawar) was used. Cultivation of skin explants 1–2 mm. square was carried out in 0·5 ml. of medium in 5-c.c. rubber-stoppered bottles in a gas phase of 60 per cent oxygen, 39 per cent nitrogen and 1 per cent carbon dioxide. The medium consisted of five parts serum (usually autologous), three parts Krebs–Ringer phosphate solution, one part 5 per cent glucose and 1 part streptomycin (500 units per ml.). The explants were lightly smeared with 'Vaseline' and floated on the surface of this medium. During cultivation the explants were rocked through 15° each way from the horizontal at about five times per minute.

The principle of the experiment was to compare the effects of tuberculin *in vitro* upon skin explants obtained from tuberculin-sensitive and normal guinea pigs. Sensitization was induced by the intradermal injection of heat-killed tubercle bacillus or by B.C.G. vaccination. The sensitized guinea pigs reacted to at least 1 : 1,000 old tuberculin and gave reactions from 1·5 to 2 cm. in diameter to 1 : 100 old tuberculin.

During cultivation for periods of up to three days, no differences could be detected in the amount and quality of growth between the sensitized and non-sensitized skin even in the presence of very high concentrations of tuberculin. In some instances the concentration of tuberculin (purified protein derivative, 0·2 mgm./ml.) was a hundred times that necessary to produce a tuberculin reaction *in vivo* (Fig. 2).

Proof of the presence of tuberculin in the medium after cultivation was afforded by the intradermal injection of 0·05 ml. of the medium into a sensitized animal in some of the experiments. Definite reactions were produced, although the diameter was somewhat smaller than that produced by the same concentration of fresh tuberculin.

The contrast between the non-reactivity to tuberculin *in vitro* and the tuberculin reaction *in vivo* is striking, and suggests that whatever the cause of the tuberculin reaction it is not associated with a direct cytotoxic effect of tuberculin upon sensitized skin. The evidence for the non-reactivity of the epithelium is weightier than that for the dermal cells, as the former is active in culture while the latter remain quiescent. The possibility cannot be excluded that biochemical changes may have occurred in the local tissue cells of the dermis which could not be detected by histological methods.

I wish to acknowledge the technical assistance of Mr. J. R. Cooper.

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Inheritance of the Human Blood Group Antigen *Jk*^{a}

A new human blood group antigen has recently been reported[1]. The antibody is called anti-*Jk*^{a}; it divides Europeans into two phenotypes, *Jk*(*a*+) and *Jk*(*a*−). The frequency of the antigen is the same in London as in Boston, Mass.

	Jk(*a*+)	*Jk*(*a*−)	Total
Boston	146 77·25%	43 22·75%	189
London	154 76·62%	47 23·38%	201
Combined	300 76·92%	90 23·08%	390

Fifty-one families have been tested for the new groups. The antigen *Jk*^{a} is clearly controlled by a

gene capable of expressing itself in single or double dose, for $Jk(a+)$ by $Jk(a+)$ matings can have $Jk(a-)$ children, and $Jk(a-)$ by $Jk(a-)$ matings do not have $Jk(a+)$ children. Statistical analysis of the families confirms that the inheritance depends on such a 'dominant' gene. The gene frequencies $Jk^a = 0{\cdot}5196$ and $Jk^b = 0{\cdot}4804$ can be derived from the tests on the 390 unrelated persons. From these frequencies can be calculated the proportion of children expected to be $Jk(a+)$ and $Jk(a-)$ from each of the three types of mating. Table 1 shows that the coincidence of the number of children in these categories, expected and observed, is very close.

Table 1. Fifty-one Families with 124 Children Tested for the Antigen Jk^a

Matings			Children				
				$Jk(a+)$		$Jk(a-)$	
Type	Exp.	Obs.	Total	Exp.	Obs.	Exp.	Obs.
$Jk(a+)\times Jk(a+)$	30·2	31	80	71·6	72	8·4	8
$Jk(a+)\times Jk(a-)$	18·1	14	31	20·9	20	10·1	11
$Jk(a-)\times Jk(a-)$	2·7	6	13	0·0	0	13·0	13

Because of certain objections to this manner of analysis, Fisher[2] devised a more critical method for dealing with A_1A_2BO family data which can be easily adapted to the *Kidd* groups by treating $Jk(a+)$ as group B and $Jk(a-)$ as group O. Table 2 shows the good agreement between the observed families and those expected when the calculations are made in this way.

Table 2. Analysis of $Jk(a+)\times Jk(a+)$ and $Jk(a+)\times Jk(a-)$ Matings

Class of mating	Class of family	Expected No. of families	Observed No. of families	χ^2	d.f.
$Jk(a+)\times Jk(a+)$	All children $Jk(a+)$	24·5	24	0·05	1
	Some children $Jk(a-)$	6·5	7		
$Jk(a+)\times Jk(a-)$	All children $Jk(a+)$	7·3	5	1·51	1
	Some children $Jk(a-)$	6·7	9		
				1·56 $p = 0{\cdot}42$	2

In the earlier communication[1] it was stated that χ^2 tests failed to show any relationship between the new antigen and the antigens of the *ABO*, *MNS*, *P*, *Rh*, *Lewis* or *Duffy* systems, or sex. The London results support this and also show no relationship to the antigens of the *Lutheran* or *Kell* systems, or to the ability to taste phenyl thiocarbamide.

Although all the 51 families were tested for the other blood groups, and most of them for phenyl thiocarbamide tasting, linkage information is so far rather scanty. The evidence, such as it is, is against the *Kidd* genes, Jk^a and Jk^b, being partially sex-linked or linked to the genes of the *ABO*, *MNS*, *Rh*, or *Kell* blood-group systems, or to the genes for phenyl thiocarbamide tasting.

The *Kidd* blood group is the tenth normal character in man, apart from sex, of which the manner of inheritance is known. The others are, in the order of their discovery: the *ABO*, the *MNS* and the *P* blood groups, the ability to taste phenyl thiocarbamide, the secretion of the *ABO* antigens in the saliva (with which is associated the *Lewis* blood group), and the *Rh*, the *Lutheran*, the *Kell* and the *Duffy* blood groups.

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[1] Allen, F. H., Diamond, L. K., and Niedziela, Bevely, *Nature*, 167, 482 (1951).
[2] Fisher, R. A., cited by Taylor, G. L., and Prior, Aileen M., *Ann. Eugen.*, **9**, 18 (1939).

An Extension of Kosambi's Formula

Kosambi[1] proposed the formula

$$y = \tfrac{1}{2} \tanh 2x \qquad (1)$$

as an approximate representation of the relation between the genetical map-length x of a segment and y the amount of recombination over that segment. As corollaries, we have for adjacent segments x_1 and x_2:

$$y_{12} = 2y_1y_2y_{1+2} = 2y_1y_2 \frac{y_1 + y_2}{1 + 4y_1y_2}. \qquad (2)$$

I have indicated[2] the conditions under which these approximations are valid. If, in particular, the interference is represented by the intercept function $4u \exp -2u$ employed in previous work[2-4], then, for a segment near the (metrical) midpoint of a long arm, we obtain the relation

$$y = \tfrac{1}{2}\,(1 - \cos 2x.\ \exp -2x).$$

For segments less than 35 cM. in length this function differs from $\frac{1}{2} \tanh 2x$ to an inappreciable degree, the difference in the values of y as given by the two formulæ being only 8 parts in 302 when x is 35 cM. Thus, Kosambi's formula regarded as an approximation receives a simple theoretical justification, and it is seen that it is likely to apply in median segments.

In such a region an elegant representation is available if complex numbers are employed. Introducing the auxiliary quantity z, defined by

$$z = \tfrac{1}{2} \sin 2x \exp -2x,$$

and defining a *complex recombination fraction*, $y + iz$, written as w, we have the identities:

$$1 - 2w = \exp\{-2x(1+i)\},$$

and

$$w_1w_2 = \tfrac{1}{2}(w_1 + w_2 - w_{1+2}).$$

Therefore,

$$\begin{aligned} y_{12} &= \tfrac{1}{2}\,(y_1 + y_2 - y_{1+2}) \\ &= R\{\tfrac{1}{2}(w_1 + w_2 - w_{1+2})\} \\ &= R(w_1w_2) = R(w_{12}), \end{aligned}$$

if we write w_{12} for the product w_1w_2. It is seen that w satisfies the same relation as would be obeyed by y if there were no genetical interference. Thus, for two adjacent segments the introduction of complex recombination fractions formally removes the effect of interference, making the 'complex coincidence' w_{12}/w_1w_2 equal to unity.

Also,

$$y_{12} = R(w_1w_2) = y_1y_2 - z_1z_2;$$

but since this relation approximates to that implied by (2), we obtain the useful approximate equation:

$$z_1 z_2 \simeq (1 - 2y_1)(1 - 2y_2)/(1 + 4y_1y_2), \quad (3)$$

which holds when x_1 and x_2 are sufficiently small. This last approximation, though deduced for adjacent intervals, clearly holds for non-adjacent ones also.

Hitherto there has been no extension of Kosambi's formula for simultaneous recombination to the case of non-adjacent intervals or to more than two adjacent intervals. This defect can now be remedied. Let y_1, y_2, y_3; y_{12}, y_{23}, y_{13}; and y_{123} refer to adjacent intervals x_1, x_2 and x_3 located in a median region on a long arm. Then using the method of calculation previously indicated[2], we obtain:

$$y_{13} = y_1y_3 - z_1z_3 \exp -4x_2$$

and

$$y_{123} = R(w_1w_2w_3) + \tfrac{1}{2}z_1z_3(1 - \exp -4x_2). \quad (4)$$

In the case of two adjacent intervals y_{12}, the frequency of simultaneous recombination is given by $R(w_1w_2)$. However, formula (4) shows that in the case of three such segments the analogous quantity $R(w_1w_2w_3)$ under-estimates y_{123}, as is otherwise obvious, because, relative to their lengths, the interaction between x_1 and x_3 is less than that between two adjacent segments.

Employing formulæ (1) and (3), we obtain as further approximations

$$y_{13} = y_1y_3\left\{1 - \frac{(1 - 2y_2)}{(1 + 2y_2)} \cdot \frac{(1 - 2y_1)(1 - 2y_3)}{(1 + 4y_1y_2)}\right\},$$

and

$$y_{123} = y_1y_{23} - y_2y_{13} + y_3y_{12}.$$

These formulæ have the merit of containing only the segmental recombination values y_1, y_2 and y_3. They constitute a theoretically satisfactory generalization of Kosambi's system. They enable the frequencies of the modes of gamete formation with as many as five linked loci to be expressed in terms of the segmental recombinations only.

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March 12.

[1] Kosambi, D. D., *Ann. Eugen.*, **12**, 172 (1944).
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Digestion of Alpha-Cellulose by Larvæ of *Anobium punctatum* De Geer

Parkin[1] demonstrated that the larval gut of the common house borer *Anobium punctatum* De Geer contained an enzyme or enzymes which produced reducing sugars from isolated oak α-cellulose *in vitro*. Falck[2] and Müller[3] concluded from chemical analyses of sound and digested wood that some α-cellulose was digested by the larvæ. The present investigation was undertaken to determine the amount of α-cellulose digested and its significance in the total diet of *Anobium punctatum*.

Of the four methods[1] available for investigation of the nutrition of wood-destroying insects, only the comparison of chemical analyses of sound and digested wood is applicable to this investigation. This method shows whether changes have occurred in the proportions of the constituents following digestion but cannot show the amounts digested unless an assumption is made that one component is unaffected by the digestive enzymes of the larvæ. Most workers have assumed that lignin is inert during digestion. If this is so, the amounts of other components digested are readily calculated from the lignin ratio of sound and digested wood.

Table 1. Lignin Content of Wood and Frass Samples

	Lignin content*: per cent w/w on equivalent oven-dry basis		Lignin ratio‡
	Wood	Frass	
A	31·00	38·46	0·806
B	30·79	37·01	0·832
C	30·76	37·91	0·811
D	30·13	37·30	0·808
E	33·67†	38·83	0·867
F	29·49	36·40	0·810
X	29·84	38·33	0·779

* Mean of two determinations; standard error of mean lignin value 0·14 per cent. † Mean of four determinations: 33·48, 33·89, 33·72, 33·58 per cent. ‡ Standard error of lignin ratio 0·005.

Six blocks (*A*, *B*, *C*, *D*, *E*, *F*) of sapwood kahikatea (*Podocarpus dacryloides* A. Rich.) each from a different tree and infested with *A. punctatum* were used as a source of material for analyses. A single block (*X*) of sapwood matai (*P. spicatus* R. Br.) was also used. Blocks were split, frass removed from larval tunnels, and the frass-free splints passed through a grinding mill to obtain the wood samples. The frass from each block was collected and sieved on a 100-mesh screen to free the fæcal pellets from chewings[4] of undigested wood. Wood and frass samples were extracted first with ether and then with acetone before analyses. Results are reported on a basis of extracted wood or frass. Lignin was determined by the 72 per cent w/w sulphuric acid method outlined by Purves[5]. Alpha-cellulose contents of the samples were obtained by the methods of Wise, Murphy and D'Addieco[6] and Wise and Ratliff[7], first isolating holocellulose by action of acidified sodium chlorite at 75°–80° C., and then extracting the holocellulose with 25 per cent w/w potassium hydroxide at room temperature, for three hours, under nitrogen.

Lignin content of each wood and frass sample, and their lignin ratio $\frac{\text{lignin content of wood}}{\text{lignin content of frass}}$ is listed in Table 1.

Since some wood has been destroyed by digestion, the α-cellulose values obtained by analyses of frass cannot be simply subtracted from the α-cellulose values of the matched wood sample to obtain the amount of α-cellulose digested. However, if no

Table 2. Cellulose in Wood and Frass Samples and the Calculated Digestibilities of Wood and Cellulose

	Percentage* cellulose in wood	Corrected frass cellulose†	Difference equals cellulose digested	Cellulose digested as percentage of cellulose in wood	Apparent total digestibility of wood‡	Discrepancy§
A	46·2	30·8	15·4	33·3	19·4	4·0
B	48·1	33·6	14·5	30·1	16·8	2·3
C	48·9	30·8	18·1	37·0	18·9	0·8
D	45·1	31·2	13·9	30·8	19·2	5·3
E	42·6	30·9	11·7	27·5	13·3	1·6
F	48·6	32·4	16·2	33·3	19·0	2·8
X	47·1	28·4	18·7	39·7	22·1	3·4

* By analyses of wood samples. † Cellulose in frass *X* lignin ratio. ‡ Apparent total digestibility of wood: (1-lignin ratio). § Wood digested other than cellulose (apparent total digestibility minus cellulose digested).

lignin has been digested, the lignin ratios in Table 1 are numerically equal to the weight of frass derived from a gram of ingested wood. Therefore, to obtain α-cellulose values of frass samples as a percentage of the wood ingested, the α-cellulose values obtained by analyses of frass samples have been multiplied by the lignin ratios in Table 1. The α-cellulose values of wood and the corrected α-cellulose values of frass, together with relevant calculations of digestibility of wood and α-cellulose, are given in Table 2.

From Table 2 it is apparent that differences in α-cellulose content of matched wood and frass samples account for all but a few per cent of the calculated total digestion. The wood digested, other than α-cellulose, must include some protein and probably starch and free sugars since an amylase is known to be present in the gut extracts[1].

Since only about one-third of the α-cellulose present in the wood is digested, it is interesting to speculate whether the amount of some substance or substances present in wood determines the extent to which α-cellulose can be utilized. Such material is unlikely to be part of the carbohydrate complex but could well be protein and/or accessory growth-factors, the significance of which in the nutrition of *A. punctatum* is as yet unknown.

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March 15.

[1] Parkin, *J. Exp. Biol.*, **17**, 364 (1940).
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Zinc Requirements of *Aspergillus niger*

Zinc is indispensable for the growth of all the higher plants, fungi, Actinomycetes and bacteria which have been examined, yet little is known of the role of zinc in metabolism[1,2]. Evidence has been presented recently, however, that phosphatase of *Penicillium chrysogenum* is a zinc-containing enzyme[3].

The zinc requirements of fungi have been determined largely from experiments in which glucose or sucrose has been used as the source of carbon. In the experiments described below the zinc requirements of *Aspergillus niger* were determined when the latter was grown on media involving a number of different carbon sources. The fungus was grown in surface culture in 100-ml. 'Hysil' or 'Pyrex' conical flasks in triplicate and harvested after 4 days incubation at 28° C. The basal medium contained ammonium nitrate, 0·3 per cent; dipotassium hydrogen phosphate, 0·05 per cent; magnesium sulphate, 0·05 per cent; iron, 0·5 p.p.m.; copper, 0·1 p.p.m.; and manganese, 0·05 p.p.m.

The media containing glucose, glycerol and peptone as carbon sources were purified free from zinc by extracting with chloroform solutions of diphenylthiocarbazone at *p*H 7·6[4], and those containing citric and gluconic acid by extracting with chloroform solutions of 8-hydroxyquinoline at *p*H 5·2[5]. Zinc was added as $ZnSO_4.7H_2O$ in graded amounts and growth response curves obtained.

Table 1 shows that for a given carbon source such as glucose there is a constant relationship between the amount of carbon used, the amount of growth made and the minimum amount of zinc required.

Table 1

Sole source of carbon (gm %)	Mycelial weight (gm.)	Minimum zinc requirement for optimum growth (p.p.m.)	Zinc requirement per gm. of mycelium (p.p.m.)
Glucose 0·25	0·018	0·015	0·83
Glucose 2·0	0·14	0·1	0·715
Glucose 5·0	0·38	0·3	0·79

Table 2 shows the relative zinc requirements for growth with different carbon sources.

Table 2

Sole source of carbon (gm. %)	Mycelial weight (gm.)	Minimum zinc requirement for optimum growth (p.p.m.)	Zinc requirement per gm. of mycelium (p.p.m.)
Glucose 2	0·14	0·1	0·715
Glycerol 5	0·069	0·05	0·725
Gluconic acid 5	0·15	0·015	0·10
Citric acid 5	0·074	<0·01	<0·13
Peptone 1	0·02	0·05	2·5

It will be seen that zinc is essential for growth on all the carbon sources; but considerably less is required for the metabolism of organic acids than for glucose or glycerol. It would appear, therefore, that zinc is chiefly required for some process involved in the metabolism of glucose or glycerol. It will also be seen that the zinc requirements for the utilization of glucose and glycerol, while being considerably greater than for the utilization of acids, are similar to each other. This may indicate that the utilization of glucose and glycerol involves the same metabolic pathway which would be expected if the Embden–Myerhof scheme exists in fungi, and that the zinc requirement occurs in that part of the metabolic path involved in the utilization of both substances; that is to say, after the formation of the triose phosphates in the Embden–Myerhof scheme.

The apparently high zinc requirement for the metabolism of peptone may be due largely to the formation of zinc complexes with the latter, thus diminishing the available concentration of zinc.

If the similar zinc requirements for the utilization of glucose and glycerol and for gluconic and citric acid do imply a similarity of metabolism, it may be that a study of minimum trace element requirements would be of value in determining whether two substances are metabolized by similar or different pathways.

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April 6.

[1] Chesters, C. G. C., and Rolinson, G. N., *Biol. Rev.* (In the press).
[2] Chesters, C. G. C., and Rolinson, G. N., *Nature*, **165**, 851 (1950).
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A Case of Disturbed Metabolism in *Daphnia magna*

In the first half of January this year, a marked decrease in the rate of reproduction was noticed in cultures of *Daphnia magna* that are being kept on a food of different algæ (mainly *Scenedesmus* sp.) at 18–20° C. The algæ cultures are kept in large aquaria with fountain water with occasional addition of small quantities of nitrates and phosphates. These cultures are aerated artificially and illuminated with a normal light bulb.

Nothing else could be observed in the mother animals except the lack of active ovaria in many of them and a rather unusual amount of fat droplets. At the end of the same month the rate of reproduction had fallen to practically zero; the mortality had also increased, and moulting took place only exceptionally. Closer observation of the animals revealed the fact that they were completely filled with fat droplets of a pink colour. These fat droplets formed a massive cover around the intestinal tract, from the first third of it down to the anus, while a great number of them could even be found at the base of the abdominal end claws. The thoracic appendixes were filled with droplets of the same colour, and they were even detected around the nephridia. Of the ovaries nothing could be seen. While well-fed *Daphnia magna* (with large fat reserves) can be starved for many days, during which they use up the fat, these abnormal animals would not consume their fat reserves during starvation, but died within about two days.

This irreversible fat-storage led to the idea that the *Daphnia* might be deficient in some substance, which either the algæ or the animals could not produce under the conditions offered to them. To find out whether there was really a kind of deficiency involved or not, the following experiments were made.

The animals were split into five groups of equal numbers: (1) and (2) the animals were kept as controls and continued to feed upon the mixture of algæ as before; (3) besides algal food, the animals received finely dispersed egg-yolk for twelve hours every day; (4) instead of egg-yolk a suspension of baker's yeast was given for twelve hours every day; (5) the animals received the same food as before, but they were put twice a day under the light of a mercury arc (Original-Hanau Analysen-Quarzlampe) for five minutes at a time, at a distance of 20 cm. from the arc, using a filter.

Results. After the first day of treatment the animals of groups (3) and (4) already showed increased vitality. After the second day of treatment first signs of resumed ovarian activity were observed in both groups. The control animals and those of group (5) showed no change in behaviour. After the third day all animals of group (3) had moulted and most of them carried summer-eggs. In group (4) most animals had moulted and showed active ovaria. The other animals continued to die and no moulting was observed. After the fourth day some animals of group (3) released young, and all animals were now carrying summer-eggs. *Daphnia* of group (4) showed eggs of the same type. Groups (1), (2) and (5) still showed no signs of improvement. After this, treatment was stopped and all animals were put back on normal food. While the animals of groups (1), (2) and (5) still showed the same pink colour as before, those of groups (3) and (4) looked pale; their fat reserves were of yellowish colour and reduced to normal size.

In the following days, some of the control animals and some of group (5) also showed some improvement—moulting and a slight egg-production.

Situation after three weeks. The animals of groups (3) and (4) have a high reproduction-rate (about 20 young per moult per animal); colour, yellowish-brown; fat storage small; about two-thirds of the animals have died since the beginning of the treatment. The control animals and those of group (5) have a poor reproduction (2–3 young per moult per animal); low vitality; pink colour, with abnormal large fat accumulations; of forty-five animals at the beginning of the experiment only three are still living.

It should be mentioned that during this period of abnormal behaviour the production of males or of sexual eggs was never noticed; this is true for the treated animals as well as for the untreated ones. The oxygen consumption, as measured by the Warburg technique, showed the following figures in c.mm. oxygen per 15 min. per mgm. dry weight: before and after metabolic disturbance, $M = 2{\cdot}97$ c.mm./15 min./mgm., $\varepsilon = \pm 0{\cdot}10$; during period of disturbed metabolism, $M = 5{\cdot}50$ c.mm./15 min./mgm., $\varepsilon = \pm 0{\cdot}16$.

These results support the idea that the abnormal metabolism described above has its origin in some food deficiency. Of course, the complexity of the egg-yolk and of the yeast does not allow the type of deficiency to be specified.

Edw. Flückiger

Institute of Limnology,
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University of Lund. March 15.

Heart-beat of the Hibernating Hedgehog

The most characteristic feature of the physiology of hibernation is the changing of a homoiothermic mammal within certain limits into a poikilothermic animal. Thus, for example, the body temperature of the hedgehog may decrease during hibernation to about 2° C. When the animal wakes from hibernation, its body temperature rises in some hours from 2°–5° C. to 30°–35° C. again, and the animal returns to homoiothermy.

Owing to the low body temperature, the metabolism of the animal is greatly reduced during hibernation. This also has an effect on the heart function. The effect of hibernation on the physiology of the heart and the circulatory system has been but little investigated, however (cf., for example, Endres and collaborators[1], Ferdmann and Feinschmidt[2], and Suomalainen and Sarajas[3]).

With the aid of electrocardiograms we found that the mean normal heart-beat of the hedgehog (body-weight 420–920 gm.) is 188 per min. During hibernation (body-weight 420–770 gm., body temperature 6·2–7·7° C.) the mean heart-beat was 21 per min. The reason for this is primarily the lowering of the body temperature and strengthening of vagus tone, probably also increase in magnesium, decrease in potassium, and increase in carbon dioxide content of the blood during hibernation.

Paavo Suomalainen
Samuli Sarajas

Zoological Laboratory,
University of Helsinki. April 5.

[1] Endres, G., Matthews, B. H. C., Taylor, H., and Dale, Alison, *Proc. Roy. Soc.*, B, **107**, 222 (1931).
[2] Ferdmann, D., and Feinschmidt, O., *Ergebn. Biol.*, **8**, 1 (1932).
[3] Suomalainen, Paavo, and Sarajas, Samuli, *Ann. Zool. Soc. 'Vanamo'*, **14**, 2, 1 (1951).

FORTHCOMING EVENTS

Wednesday, August 8—Wednesday, August 15

British Association for the Advancement of Science (at Edinburgh).—Annual Meeting.

Wednesday, August 8

At 8.15 p.m.—H.R.H. The Duke of Edinburgh, K.G., F.R.S.: "The British Contribution to Science and Technology in the Past Hundred Years" (Presidential Address).

Thursday, August 9

At 10 a.m.—Sir David Brunt, F.R.S.: "A Hundred Years of Meteorology (1851–1951)" (Presidential Address, Section A).

At 10 a.m.—Sir Cyril Hinshelwood, F.R.S.: "Chemistry at the Mid-Century" (Presidential Address, Section B).

At 10 a.m.—Dr. C. F. A. Pantin, F.R.S.: "Organic Design" (Presidential Address, Section D).

At 10 a.m.—Dr. O. J. R. Howarth: "The Centenary of Section E" (Presidential Address, Section E).

At 10 a.m.—Sir Henry Beresford-Peirse, Bart.: "British Forestry in the Last Century" (Chairman's Address, Section K*).

At 10 a.m.—Dr. E. M. Crowther: "Experimental Agriculture" (Presidential Address, Section M).

At 12 noon—Prof. C. A. Mace: "Psychology and the Laity" (Presidential Address, Section J).

At 12 noon—Prof. W. Brown, F.R.S.: "Mycology over a Century" (Presidential Address, Section K).

At 2.30 p.m.—Dr. D. A. Allan: "The Scottish Scene" (Presidential Address, Conference of Delegates of Corresponding Societies).

At 5.30 p.m.—Sir Edmund Whittaker, F.R.S.: "Eddington's Principle in the Philosophy of Science" (Eddington Memorial Lecture).

Friday, August 10

At 10 a.m.—Prof. R. G. Hawtrey: "The Nature of Profit" (Presidential Address, Section F).

At 10 a.m.—Sir Claude Gibb, F.R.S.: "Two Thousand Years of Engineering" (Presidential Address, Section G).

At 10 a.m.—Sir Cyril Fox: "The Study of Early Celtic Metalwork in Britain" (Presidential Address, Section H).

At 10 a.m.—Sir Hector Hetherington, K.B.E.: "Mid Century—Retrospect and Prospect" (Presidential Address, Section L).

At 5.30 p.m.—Prof. C. A. Coulson, F.R.S.: "The Place of Science in the Christian Faith" (arranged by the Research Scientists' Christian Fellowship).

At 8 p.m.—Prof. John Read, F.R.S.: "Alchemy and Alchemists".

Sunday, August 12

At 8 p.m.—The Very Rev. John Baillie: "Natural Science and the Spiritual Life."

Monday, August 13

At 10 a.m.—Prof. W. B. R. King, F.R.S.: "The Influence of Geology on Military Operations in North-West Europe" (Presidential Address, Section C).

At 10 a.m.—Prof. H. P. Gilding: "Physiology of the Capillaries" (Presidential Address, Section I).

At 7.30 p.m.—Session on "World Communications—The Impact of Speed" (Speakers will include Sir Edward Appleton, F.R.S., Sir Ben Lockspeiser, F.R.S., Dr. Edward Warner and Prof. P. Auger).

At 8 p.m.—Sir Edward Salisbury, F.R.S.: "The Contemplative Gardener."

APPOINTMENTS VACANT

Assistant (Scientific) in the Plant Protection Chemistry Section—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (August 11).

Head of the Engineering Department, and a Head of the Natural Science Department, of the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges of Arts, Science and Technology, 15 Victoria Street, London, S.W.1 (August 11).

Junior Cytogeneticist at the Commonwealth Potato Collection at Cambridge—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (August 11).

Physical Chemist on the Engineer's Staff—The Clerk to the Birmingham Tame and Rea District Drainage Board, 117 Colemore Row, Birmingham 3 (August 11).

Physicist to the Radiotherapy Department—The Secretary, Romford Group Hospital Management Committee, Oldchurch Hospital, Romford, Essex (August 11).

Assistant Lecturer or Lecturer in the Department of Botany, with a special interest in mycology—The Secretary, The University, Edmund Street, Birmingham 3 (August 13).

Lecturer in the Biochemistry Department, and an Assistant in Pathology in the Department of Animal Pathology, in the University Veterinary School—The Secretary of University Court, The University, Glasgow (August 15).

Lecturer (with a good honours degree in chemistry, research experience in physical chemistry, and prepared to teach the subject to B.Sc. Special standard) in Physical Chemistry, and an Assistant (with a degree in electrical engineering, or some equivalent qualification) in the Department of Electrical Engineering—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (August 15).

Professor and Head of the Department of Aircraft Design—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks, endorsed 'Professor of Aircraft Design' (August 15).

Engineer I at a Ministry of Supply establishment in Berkshire, for design and development work on schemes for production of useful power from atomic energy—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.68/51A (August 18).

Engineer I by the Ministry of Supply in London, for capacity assessment in aircraft manufacture and repair, advice on jigging, tooling, repair methods, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.411/51A (August 18).

Engineer/Chemist I by the Ministry of Supply in London, to be responsible for planning and production of respirators and anti-gas stores—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.412/51A (August 18).

Lecturer in Electrical Engineering—The Registrar, King's College, Newcastle-upon-Tyne (August 18).

Research Studentship in the Department of Physics (in the field of U.H.F. radio research)—The Registrar, University College, Hull (August 18).

Assistant Registrar (woman, graduate, preferably in Science)—The Principal, Royal Holloway College, Englefield Green, Surrey (August 20).

Studentships in Biophysics and in Medical Physics—The House Governor, Royal Cancer Hospital, Fulham Road, London, S.W.3 (August 20).

Junior Technical Assistant (Electrical) in the Engineering Branch of the Production Department at London Headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting T/362 (August 21).

Principal Scientific Officer in the Intelligence Division of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4051/51 (August 23).

Lecturer in Electrical Engineering, and a Statistician (temporary) in the Department of Social and Industrial Medicine—The Registrar, The University, Sheffield (August 25).

Research Microbiologist in the domestic preservation of fruit and vegetables section at Long Ashton Research Station—The Registrar and Secretary, The University, Bristol (August 25).

Head of the Department of Mathematics (with the status of Reader), Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (August 31).

Senior Lecturer in Geography at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 8).

Chair of Civil Engineering at the University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Adelaide, September 30).

Agricultural Superintendent for extension work in Sierra Leone—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27059/220.

Assistant Forecaster (with a university degree, preferably in science and specialized in meteorology) for the Basrah Port Directorate—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.26338.E.

Assistant Lecturer in Pharmacognosy—The Secretary, Royal Technical College, Glasgow.

Assistant Research Manager in the Research and Development Branch, Windscale Works, Sellafield, Cumberland, to lead an applied research group investigating a wide range of problems associated with atomic energy development—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

Cerealist by the Government of Iraq for the Directorate General of Agriculture, to improve the field and quality of cereal crops (mainly barley, wheat, rice and millet) by selection and breeding—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.18187.A.

Consultant Scientist (preferably with a degree in bacteriology, mycology or biochemistry) to advise the Ministry of Agriculture on the utilization and conservation of horticultural products grown in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Consultant Scientist 401'.

Demonstrator in Pharmaceutical Subjects—The Registrar, Municipal College, Portsmouth.

Departmental Assistant (university graduate) in Agriculture at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

Graduate (with a science degree, with physics or mathematics) for operational research in the wool industry—The Secretary, Wool Industries Research Association, Torridon, Headingley, Leeds 6.

Insecticide Chemist in the West African Cacao Research Institute—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting 27106/39.

Lecturer in Dairy Husbandry at Massey Agricultural College, Palmerston North, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

Lecturer in Mathematics, and an Assistant Lecturer (Grade B) in the Department of Chemistry—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

Lecturer in Pure Mathematics or Applied Mathematics—Prof. W. G. Guthrie, Magee University College, Londonderry.

Male Assistant (Scientific) in the Hydraulics Research Organization (Department of Scientific and Industrial Research), Wallingford, to assist in hydrographic surveying of beaches and estuaries and also to assist in research into the effect of waves and currents on beaches—The Ministry of Labour and National Service, Wallingford, Berks, quoting No. 141.

Public Health Engineer in the Public Works Department, Sierra Leone, to undertake anti-malarial drainage and other urban works—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27322/201.

Senior Physicist to the Radiotherapy Department—The Group Secretary, Wolverhampton Hospital Management Committee, Royal Hospital, Wolverhampton.